STATUS OF WILDLIFE RESEARCH IN THE BORDERLANDS ECOSYSTEM MANAGEMENT PROGRAM

by
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INTRODUCTION

Federal and state land management agencies in cooperation with local landowners have initiated an ecosystem program on approximately 400,000 ha in the San Bernardino-Animas area of southeastern Arizona and southwestern New Mexico; the borderlands of the southwestern United States of interest to researchers and land managers. Human populations are increasing, placing addition strain on limited land, water, and wildlife resources in the program area. The San Bernardino-Animas project area is an unique, relatively unfragmented, landscape containing an unbroken series of natural communities ranging from desert grasslands to mixed conifer forests. It has been selected by the Coronado National Forest as an area for implementing and demonstrating ecosystem management strategies. Much of the information gained from this project can be extended to the management of the larger Madrean Archipelago biogeographical region that is located throughout southeastern and south-central Arizona, southwestern New Mexico, and northern Mexico.

The Borderlands Ecosystem Management Program is located biogeographically in the Madrean Archipelago, which is a region having exceptional biodiversity and great biogeographic interest. The Madrean Archipelago is that portion of the Basin and Range Physiographic Province south of the Rocky Mountains and north of the Sierra Madre Occidental in southeastern Arizona,

southwestern New Mexico, northeastern Sonora, and northwestern Chihuahua. Lowlands of this region support Sonoran Desert and thornscrub vegetation to the west, Chihuahuan Desert to the east, and desert grasslands occupy much of the center of the region. Depending on elevation, isolated mountain ranges support oak (Quercus spp.) and pine (Pinus spp.) -oak woodlands, pine forests, and on the highest ranges, spruce (Picea spp.) -fir forests. The flora of this region is a diverse mixture of endemic, Rocky Mountain, and Madrean species and is one of the most floristically diverse areas in North America. Individual mountain ranges may support up to 1,000 different native species.

The 400,000 ha Borderlands Ecosystem Program area is under multiple ownership and administration. Fifty-three percent of the land is in private ownership, 23% in state ownership by Arizona and New Mexico, 17% by the Coronado National Forest, and 7% by the Bureau of Land Management. As a result, the program represents a joint effort and partnership in ecosystem management among private, state, and public land owners.

An important component of this contracted research is to bring together the technical information on the wildlife resource in the Borderlands area and to relate this information to other important soil, water, and vegetation resources, and to finally use this information as the basis for formulating and designing a field experiment to evaluate wildlife responses to different management treatments. The study being proposed is conceptually a replicated field experiment carried out on ≥ 1 important vegetation-soil associations representative of the project area. The experiment would be designed to answer questions concerning the influence of a wide range of management activities (e.g., fire, grazing, herbicides, supplemental fertilizers [including carbon additions], mechanical treatments, and climate changes [water additions]) on ecosystem responses (including soil, water, erosion, wildlife, brush-grass equilibria, and others). The treatments (and combinations of these

treatments) examined by this study would be replicated on several areas representing the most important vegetation-soil associations on the project area. Soil, plant, water, and wildlife responses to treatment would be coordinated and studied simultaneously on all study sites, or satellite areas where special study design configurations are required to more adequately evaluate a resource response.

However, the above approach, while conceptually appealing, requires careful development of a research plan that integrates the many environmental factors influencing wildlife over the landscape. The goal of this cooperative agreement is to identify current wildlife research issues, prioritize research topics and develop an integrated plan for conducting wildlife research in the Borderlands. This integration will consider and be coordinated with similar efforts being developed for vegetation, watershed, soils, and related resources.

METHODS

We conducted a literature search on faunal studies conducted in southeastern Arizona, southwestern New Mexico. northeastern Sonora, and northwestern Chihuahua. We conducted the search at the Science and engineering Library at the University of Arizona. We used a computer retrieval system called QuickSearch that has access to hundreds of databases. We used 11 databases in conducting our search: 1) BIOSIS PREVIEWS; 2) Life Sciences Collection; 3) Enviroline; 4) Pollution Abstracts; 5) CAB Abstracts (formerly called Commonwealth Agricultural Bureaux); 6) Environmental Bibliography; 7)NTIS (National Technical Information Service); 8) PASCAL; 9) Zoological Record

Online; 10) CA Search (Chemical Abstracts Search); and 11) SciSearch.

BIOSIS PREVIEWS covers research conducted from 1969 to the present in the biological

and biomedical sciences. Life Sciences Collection covers abstracts from worldwide research literature from 1978 to the present in areas of biology, medicine, biochemistry, ecology, microbiology, agriculture, and veterinary sciences. Enviroline covers the world's environmental related information from 1971 to the present in areas such as management, planning, technology, science, geology, biology, and law. Pollution Abstracts contains references from 1970 to the present on environmentally related technical literature on pollution, its sources, and its controls. The CAB Abstracts covers information on agriculture from 1984 to the present. Environmental Bibliography covers periodicals on human and animal ecology, air, energy, land resources, water resources, and health and nutrition from 1973 to the present. The NTIS consists of summaries from 1964 to the present on United States government-sponsored research development and engineering. PASCAL covers physics, chemistry, life sciences, applied sciences and technology, earth sciences, and information sciences from 1973 to the present. Zoological Record Online provides coverage from 1978 to the present of the world's zoological literature with particular emphasis on systematic/taxonomic information. The CA Search covers applied chemistry, biochemistry and biology, and organic and inorganic chemistry from 1967 to the present. SciSearch is a multidisciplinary index to the literature of science, technology, and biomedicine covering 1974 to the present.

AVIFAUNA

Geographic Distribution

We found approximately 100 papers dealing primarily with the geographic distribution of birds in Arizona. Of these papers, about 20 covered the general statewide distribution of birds (that included reference to the borderlands), 40 pertained to distributions in the borderlands, and 40

concerned the distribution of specific species in the borderlands.

Workers began reporting on bird distribution in the 1880's, although accounts were brief and scarce. For example, until 1920, < 25 papers had been published on bird distribution in the region. Likewise, only about 15 papers were published during the 1930-1940s. A substantial increase in publications on distribution occurred in the 1950-1960s, with > 30 papers published. Phillips et al. (1964) published their renowned "The birds of Arizona" during this period. The intensity of work declined after the 1960s, with the post-1980s period seeing the slowest publication rate of distribution papers. This is due primarily to the extensive survey work done from the 1940s to the 1970s; that is, the general distribution of most birds is now known.

Key regional publications include Brandt's (1951) "Arizona and its bird life", and Friedmann et al's. (1950) and Miller's (1957) publications by the same name, "Distributional check-list of the birds of Mexico". Some species lists, such as Osgood (1903), "A List of Birds Observed in Cochise County, Arizona", and Smith (1908), "Some Data and Records from the Whetstone Mountains, Arizona" can be used as general (qualitative) comparisons with more recent survey data.

Important statewide works include Phillips et al. (1964) "The birds of Arizona", Bailey's "Birds of New Mexico", and Swarth's, "A distributional list of the birds of Arizona." There have been no state or region-wide summaries published since Phillips et al. (1964). The Arizona Department of Game and Fish has, however, organized a large volunteer effort designed to catalog the breeding distribution of all birds in the state. This "atlas" is scheduled for completing by 2002, and should provide an excellent, albeit cursory, update on the distribution of breeding birds. A similar effort has not been initiated in New Mexico.

There are numerous "first-sighting' observations and various extraliminal occurrences in the

literature. Also included are a few notes on birds of recent management concern (e.g., becard [add sci. name], trogon [add sci. name]). Major species (or groups of species) receiving attention were cowbirds (add sci. name), thick-billed parrots (add sci. name), gallinaceous birds (especially the masked bobwhite [add sci. name]), doves and pigeons (family names?), and raptors.

Natural History

Slightly over 300 papers have been published on avian natural history in the borderlands; about 75 of these dealt primarily with breeding biology. Approximately 30 papers related to general natural history studies through the 1950s. The record reveals extensive interest in describing nest locations and description of eggs during the early 1900s. A notable paper was Marshall's (1957) "Birds of pine-oak woodland in southern Arizona and adjacent Mexico." A substantial increase in publishing was seen, however, beginning in the 1960s, and continuing to date. Most recent studies can be classified as "ecological" in nature, rather than "descriptive" as typifies the earlier work. Many papers have been published on raptors (> 50), sparrows (40), gallinaceous birds (25), flycatchers (20), and hummingbirds (20).

Conservation and Management

Little was written on conservation and management prior to 1920. Interest began to rise in the 1920-30s, with publications concentrating on the status of quail and doves, and discussions of the impacts of cowbirds on other species. There was a large increase in publications during the 1960-70s, due primarily to interest in fire cycles, changes in riparian areas, along with continued interest in gallinaceous birds. The publication rate has continued to rise to date, with special interest given to grazing, fire, and parrots (add sci. name).

Much of the recent interest in grazing and fire was because of publications by C. and J.

Bock, based on their work on and around National Audubon's Research Ranch Sanctuary near Elgin, Arizona. Whereas the general ecological literature contains many publications on grazing, fire, and water (riparian) issues, there are very few studies specifically aimed at these topics and their impacts on birds. There are virtually no papers on fragmentation, corridors, the role of exotic animals, disease, human disturbance, and the like, and the direct impacts on birds.

Species-specific studies of rare species and other species of high interest (primarily game birds) predominate, although most publications are simply restatements of problems, or plans to conduct research or management. This is especially evident with the parrot, Mearn's quail (add sci. name), and masked bobwhite.

Ongoing studies

Because of concern over the apparent decline of neotropical migrant birds, effort is now being expended by many public and private agencies to determine the reasons for this decline, and to establish baseline data on abundances for future determinations of trends in numbers. The multi-agency organization, "Arizona Partners in Flight" (PIF), has compiled the only current list of projects currently underway in the state. We reviewed the 1995 list (available from S. Sferra, Nongame Branch, Arizona Game and Fish Department, Phoenix) for projects being conducted in the borderlands region. Projects had been divided into research, monitoring, and management topics by PIF. Of about 22 projects being conducted in the borderlands, 6 were classified as research, 14 as monitoring, and 2 as management. The monitoring studies included several major bird-counting efforts on the Coronado National Forest, and 3 were centered on the recently listed (under the Endangered Species Act) southwestern willow flycatcher (add sci. name). No studies were being conducted on the effects of grazing, exotic species (plants or animals), fire, or fragmentation on

birds.

A compilation of ongoing studies has not been completed for New Mexico. S. Williams, New Mexico Department of Game and Fish, has, however, initiated numerous studies in southwestern New Mexico (S. Williams, pers. commun.). These studies include general breeding bird surveys, and specific studies on elegant trogons (add sci. name), whiskered screech owls (sci. name), grasshopper sparrows (sci. name), and various hummingbirds (sci. names?).

The Arizona Breeding Bird Atlas will provide site-specific data on breeding birds and establish a computerized database on statewide distribution and abundance. The overall purpose of the project (similar projects are being conducted nationwide) is to identify the distribution and relative abundance of breeding birds in Arizona and document future changes in range. The information will provide directions for further habitat assessments for selected priority species and will also increase our knowledge of breeding, distribution, and areas of significant concentration.

MAMMALS

Taxonomic Affiliation

Seventy research papers addressed mammalian fauna in the borderlands, including a general treatise by Mearns (1907). Of the other 69, 3 were about lagomorphs, 33 were about rodents, 5 were about carnivores, and 28 were about ungulates.

All lagomorph papers were about the black-tailed jackrabbit (Lepus californicus). One compared densities between rangelands in fair and good condition, 1 addressed the contribution of shrub pruning to litter input, and 1 discussed diets.

Rodent papers addressed the genera Chaetodipus, Dipodomys, Microdipodops, Neotoma, Onychomys, Perognathus, Peromyscus, Reithrodontomys, Sigmodon, and Spermophilus. Four

papers addressed bird species simultaneously, 9 addressed ants simultaneously, and 8 addressed interactions among rodent species. Of the 33 rodent papers (including those that addressed other species simultaneously), 18 were about habitat use, trophic relationships, and foraging strategies (topics with considerable overlap). Five addressed spatial distribution, including 1 specifically on home range size. Four were management oriented. Two were on reproductive biology. Each of the following were addressed by 1 paper: activity patterns, den sites, paleoecology, population dynamics, and methodology (measurement of granivory).

Four of the carnivore papers were exclusively about coyotes (Canis latrans); 1 on the incidence of leptospirosis, 1 on the activity patterns of different-age pups, 1 on diet, and 1 on the response to liquid bait devices. The fifth carnivore paper was on the effects of predator (i.e. coyote, bobcat [Felis rufus], red-tailed hawk [Buteo jamaicensis], great-horned owl [Bubo virginianus]) exclusion on rodent abundance.

Of the 28 papers written on ungulates, topics included the use of sacaton grasslands by javelina (Tayassu tajacu), habitat use of sympatric populations of bighorn (Ovis canadensis) and mule deer (Odocoileus hemionus), and disease of Barbary sheep (Ammotragus lervia) and bighorn. The remaining 22 papers were about bighorn sheep; 5 on general management strategy, 4 on the status of a herd, 3 on post-release study results, 2 each on social structure, disease and parasites, and recreational use of bighorn, and 1 each on reproductive strategy, movement patterns, extinction probabilities, and habitat use.

Geographic Distribution

Recent mammalian study in the Southwest has largely ignored the topic of geographic distribution. Of the 70 mammalian papers, 4 dealt with distribution to a considerable degree, and

for only 2 (Brown and Henry 1981, Mearns 1907) is distribution a primary topic. Brown and Henry (1981) discussed distribution of Coues deer, and Mearns (1907) provided historical reference that provides benchmark distribution data for today's researchers and managers. Two bighorn studies (Krausman et al. 1979; Watts 1979) that focused on the status of a herd addressed the distribution of the respective herd.

Papers are exclusively from studies in Arizona and New Mexico. For general distribution data, the best sources are books such as Mammals of Arizona (Hoffmeister 1986), Mammals of New Mexico (Findley 1975), Mammals of Chihuahua (Anderson 1972), and Leopold's (1959) Wildlife of Mexico.

Natural History and Ecology

Of the 70 mammalian papers, 33 were primarily ecological, and 17 dealt with matters of natural history. The most comprehensive natural history was presented by Mearns (1907). Species receiving the most attention in more recent times include the rock squirrel, (Spermophilus spp.) coyote, and bighorn. Included among the natural history literature are 5 papers that address social structure and reproductive traits (4 of these 5 are on bighorns) and 4 that address movement patterns (3 on bighorns). Diet and the presence of a disease account for 2 papers each.

The ecologically oriented papers were most prevalent in the literature on rodents. A broad scope of rodent ecology has been examined, especially from research sites in southeastern Arizona. There is an emphasis on the interaction of rodents and other species, niche segregation, foraging strategies, and granivory and its effects on the plant community.

Conservation and Management

As the ecological literature was prevalent for rodents, management literature is likewise for

ungulates. The ungulate literature is composed primarily of bighorn papers, and management of bighorns is the most common management topic in the literature. Bighorn management is the primary theme of 11 papers, including 5 status reports for individual populations. The broadest scope of management concern is contained in Neal's (1974) "Desert bighorn sheep in Arizona -- in the year 2000".

Some papers are not included among the 11 management papers, but are clearly related to management. For example, Bavin's (1980) "Post-release study of desert bighorn sheep in the Big Hatchet Mountains, New Mexico" was classified as a natural history paper, because it focused on movement patterns. However, it also documented a management activity.

The 5 papers on carnivores were readily applicable to management, and 1 of the jackrabbit papers was explicit in offering management implications. Management papers from the rodent literature included 2 on the impacts of livestock (Bock et al. 1984, Heske and Campbell 1991), 1 on the response to burning (Bock and Bock 1978), and 1 on the impacts of farming (Mellink 1985). Overall, however, the rodent literature seemed to be the most abstract and abstruse.

Journals, Chronology, and Authors

Outside of the literature on ungulates and the general treatise of Mearns (1907), there were no papers detected that were published before 1973. The literature on ungulates includes several works from the 1950s and 1960s on bighorns. Ungulate papers have retained a steady presence in the literature throughout the latter half of the 20th century. The rest of the mammal literature reflects an increase in research beginning in the mid-1980s and continuing to the present, with a proliferation of work on rodents.

There is an obvious dichotomy within the mammalian literature between the rodent and

ungulate material. Most rodent papers have been published in Ecology, Journal of Mammalogy, or other similar journal. Reflecting the preponderance of bighorn literature in the ungulate material, the most prevalent forum for publication has been the Desert Bighorn Council Transactions.

Overall, of the peer-reviewed journals, Ecology has contributed the most mammalian papers (12). Journal of Mammalogy (6), Southwestern Naturalist (6), and Journal of Range Management (5) have been the next most common publishers. The Desert Bighorn Council Transactions have contributed 14 papers. All other sources have contributed ≤ 3 papers. Surprisingly, the Journal of Wildlife Management and the Wildlife Society Bulletin have been the source of only 1 paper each.

Reptiles and Amphibians

Only 22 papers addressed reptiles and amphibians in the borderlands. Life history and habitat papers constituted the largest category ($n = 10$) and 12 covered an array of topics: new species, species descriptions, venom characteristics, parasites and disease, predation, coexistence, hybridization, and changes related to habitat. There was no single arena that authors concentrated on and many of the published papers were notes.

CONCLUSIONS

The history of faunal research in the borderlands is not unlike that of most studies of wild animals. Early (late 1800s to the 1960s) work concentrated on determining what species occurred in the borderlands; in essence, an era of discovery. Little effort is now expended by the scientific community in this area of study, as witnessed by the substantial decrease in papers in the area since 1980. The vast majority of work now concerns various aspect of ecology, with no particular emphasis in any specific topic. An exception is work in establishing monitoring programs for tracking changes in bird abundance over time. Ecological papers on mammals have emphasized the

interaction of rodents and other species, niche segregation, foraging strategies, and the effects of grainivory on the plant community. If an area of emphasis does exist for birds, it centers on the study of various rare and endangered species. Funding now available through Arizona Game and Fish Department's "Heritage" program has stimulated much work in this area. Bighorn sheep, coyotes, and rock squirrels have received the most attention in mammalia natural history papers. Management papers for mammals have focused on the states and propagation of bighorn sheep.

Concomitant with the general rise of the "environment movement" during the 1970s was a rise in conservation-related studies in the borderlands. Although some early discussion was given on apparent negative impacts of livestock grazing on wildlife, little quantitative work was conducted prior to the 1980s. Likewise, although the history of studies of fire began earlier than those on grazing, little work was conducted prior to the 1980s. With the exception of bighorns, there is a glaring paucity of literature on large species of great economic and aesthetic importance.

Beginning in the early 1990s, efforts were initiated to develop statistical valid data bases of the distribution and abundance of birds throughout the region. Several major monitoring studies were initiated on the Coronado National Forest, and the statewide breeding bird atlas naturally includes the borderlands. It is hoped (by state and federal agencies) that these monitoring projects will allow quantitative evaluation of changes in bird numbers into the future. In addition, several monitoring efforts were initiated on rare and endangered species, including the Mexican spotted owl, southwestern willow flycatcher, elegant trogon, and buff-breasted flycatcher.

However, no detailed analyses are being conducted on the influence of specific, human-induced modifications of the environment on birds, mammals, or reptiles and amphibians. For example, although our review found an increasing interest in the effects of fire, grazing, and other

environmental perturbations on birds since the 1980s, no studies have been initiated during the 1990s.

Thus, the influence of changes in numerous aspects of the environment on fauna need study. The U.S. Forest Service, and especially the Rocky Mountain Forest and Range experiment Station, are instituting studies under the rubric of "ecosystem management". These studies seek, in part, to develop methods of restoring ecosystems to conditions that existed during the early 1800s. As such, studies are needed that evaluate the response of animals to varying successional patterns. In addition, renewed efforts are needed in determining the impacts of varying degrees of fire, grazing exotic plants and animals (including feral animals), and other impacts on animals at varying spatial scales. No work has been conducted on the influence of patch (vegetation) size, fragmentation of habitats, the usefulness of corridors linking disjunct habitats, and the like. The influence of human disturbance on animals, especially rare and endangered species, needs study. These subjects should receive more attention as ecosystem management evolves and policy-makers are faced with decisions involving indicators of ecosystem health.

AVIFAUNA

GEOGRAPHIC DISTRIBUTION

Regional

1880s

Birds of the boundary.
Baird, S. F. 1859.
In Report on the United States and Mexican boundary survey by W. H. Emory, Washington, D.C. 20(2):1-32.

Additional notes on some birds collected in Arizona and the adjoining province of Sonora, Mexico, by Mr. F. Stephens in 1884; with a description of a new species of Ortyx.
Brewster, W. 1885.
Auk 2:196-200.

Notes on an ornithological trip in Arizona and Sonora.
Stephens, F. 1885.
Auk 2:225-231.
*Running account of the birds observed on a trip from Tucson to the Gulf of California.

List of mammals and birds collected in northeastern Sonora and northwestern Chihuahua, Mexico, on the Lumholtz archaeological expedition, 1890-92.
Allen, J. A. 1893.
Bull. Amer. Mus. Nat. Hist. 5(3):27-42.

1900-1920

A list of birds observed in Cochise County, Arizona.
Osgood, W. H. 1903.
Condor 5:128-131.
*Annotated list of 72 species; provides abundance and residency status for a site near Willcox in 1894-95.

A list of birds observed in Cochise County, Arizona.
Osgood, W. H. 1903.
Condor 5:149-151.
*Annotated list of 51 species.

Birds of the Huachuca Mountains, Arizona.
Swarth, H. S. 1904.
Pac. Coast Avi. 4:1-70.

On bicycle and afoot in the Santa Catalina Mountains.

Willard, F. C. 1905.
Condor 18:156-160.
*A running account of birds observed in May, 1904.

Some data and records from the Whetstone Mountains, Arizona.
Smith, A. P. 1908.
Condor 10:75-78.
*Brief accounts of birds observed in the summer months.

Some fall migration notes from Arizona.
Swarth, H. S. 1908.
Condor 10:107-116.
*Annotated list of 109 species of birds observed in the Rincon and Huachuca Mountains, Arizona.

Some owls along the Gila river in Arizona.
Gilman, M. F. 1909.
Condor 11:145-150.
*Observations on Bubo virginianus, Aluco pratincola, Otus trichopsis (= Otus asio), Speotyto cunicularia, Glaucidium phalaenoides, and Micropallas whitneyi.

Observations taken at Madera Canyon, in the Santa Rita Mountain, between June 1st and June 14th, 1919.
Still, D. A. 1919.
Ool. 36:191.

1921-1940
Notes from southern Arizona.
Kimball, H. H. 1921.
Condor 23:57-58.
*Accounts of birds observed at Tucson, the Chiricahua Mountains, Willcox, and Yuma.

An Arizona feeding table.
Bailey, F. M. 1922.
Auk 39:474-481.
*Birds observed during the winter of 1920-21 at the foot of the Santa Rita Mountains.

Birds recorded from the Santa Rita Mountains in southern Arizona.
Bailey, F. M. 1923.
Pac. Coast Avi. 15:1-60.

Notable migrants not seen at our Arizona bird table.
Bailey, F. M. 1923.
Auk 40:393-409.

An Arizona valley bottom.
Bailey, F. M. 1924.
Auk 41:423-432.
*Birds observed in the Santa Cruz Valley near Continental, Arizona.

The faunal areas of southern Arizona: a study in animal distribution.
Swarth, H. S. 1929.
Proc. Calif. Acad. Sci. 4th ser. 18:267-383.
*Accounts of 164 species and subspecies of birds.

Report on a collection of land birds from Sonora, Mexico.
van Rossem, A. J. 1930.
Trans. San Diego Soc. Nat. Hist. 6:237-304.
*Includes comments on Arizona specimens.

Notes from southern Arizona.
Walsh, L. L. 1933.
Auk 50:124.
*Trogon ambiguus, Crotophaga sulcirostris, Dendroica virens are recorded.

1941-1960
Birds notes from southeastern Arizona.
Anderson, A. H. 1947.
Condor 49:89-90.
*Accounts of 9 species; Wood Duck is new to the state list.

Distributional check-list of the birds of Mexico.
Friedmann, H., L. Griscom, and R. T. Moore. 1950.
Pac. Coast Avi. 29:1-202.
*Mentions Arizona distribution in many of the general accounts of species.

Arizona and its bird life.
Brandt, H. 1951.
The Bird Research Foundation, Cleveland. 725pp.
*Extensive observations, chiefly of nesting, of southeastern Arizona birds.

Range, distribution and wildlife inventory of species on Fort Huachuca area.
Wallmo, C. O. 1951.
Ariz. Game and Fish Comm. Proj. 46-R-1, job no. 3:1-30.
*Includes a report on Turkey and various species of Quail.

General wildlife surveys of the Fort Huachuca wildlife area.
Wallmo, C. O. 1951

Ariz. Game and Fish Comm. Proj. 46-R-2, job no. 2:1-10.
*Data on populations and nesting of Band-tailed Pigeons, Turkey, and Quail.

Distributional check-list of the birds of Mexico.
Miller, A. H., ed. in chief. 1957.
Pac. Coast Avi. 33:1-436.

The Southwestern Research Station of the American Museum of Natural History, Portal, Arizona.
American Museum of Natural History. 1957.
*Contains a list of 200 species of birds, most of them from a list compiled by A. R. Phillips.

Records of eastern birds from the Chiricahua Mountains of Arizona.
George, W. 1958.
Auk 75:357-359.
*An account of the observation of birds in the Chiricahua Mountains of Arizona while based at Silver Spur Ranch.

Summer birds of the Chiricahua Mountains, Arizona.
Tanner, J. T. and J. W. Hardy. 1958.
Amer. Mus. Novit. 1866:1-11.
*Accounts of 114 species.

Winter bird-population study at Ranch pond in arid country
Harrison, B. [= W. I.]. 1960.
Aud. Field Notes 14:356.
*near Nogales, Arizona

<u>1961-1980</u>
An annotated checklist of spring and early summer birds for the northeastern quarter of the Chiricahua Mountains of southeastern Arizona.
Elliott, B.G. 1961.
Chiricahua National Monument, Willcox, Arizona.

Winter bird-population study at Ranch pond in arid country Harrison, B. [= W. I.]. 1961.
Aud. Field Notes 15:372.
*near Nogales, Ariz.

Birds of southeastern Arizona.
Tucson Audubon Society. 1964.
Tucson Audubon Soc. 32pp.

A birdwatcher's guide to southeastern Arizona.
Lane, J. A. 1965.

L. and P. Photography, Santa Ana, Calif. 46pp.

Recent data on summer birds of the Chiricahua Mountains area, southeastern Arizona.
Ligon, J. D. and R. P. Balda. 1968.
Trans. San Diego Soc. Nat. Hist. 15(5):41-50.
*They list 167 species during the 1964-66 breeding seasons. Golden eagles and prairie falcons have decreased in numbers, whereas harlequin quail and several species of hummingbirds and cavity-nesters have increased in numbers. The eastern bluebird has become established as a breeding species (as compared to Tanner and Hardy 1958).

Recent data on summer birds of the Chiricahua Mountains area southeastern Arizona USA.
Ligon, D. J., and R. P. Balda. 1968.
Trans. San Diego Soc. Natur. Hist. 15:41-50.

The Late Conozoic Benson and Curtis Ranch Faunas from the San Pedro Valley, Cochise County, Arizona.
Lammers, G. E. 1970.
Ph.D. dissertation. Univ. Ariz. 193 pp.

<u>≥1980</u>
The late Wisconsonian vertebrate fauna from Deadman Cave, southern Arizona.
Mead, J. I.. E. L. Roth, T. R. Van Devender, and D. W. Steadman. 1984.
Trans. San Diego Soc. Nat. Hist. 20: 247-276.

Birds in southeastern Arizona. Third ed.
Davis, W.A. 1990.
Audubon Society, Tucson.
*Updates the accounts of species and provides current suggestions on where to look for popular birds, including Sonora, Mexico.

<u>Statewide</u>

<u>1800s</u>
The birds of southeastern Texas and southern Arizona observed during May, June and July, 1891.
Rhoads, S. N. 1892.
Proc. Acad. Nat. Sci. Phila.:98-126.
*Accounts of 126 species from Arizona.

<u>1900-1920</u>
A distributional list of the birds of Arizona.
Swarth, H. S. 1914.
Pac. Coast Avi. 10:1-133.

*Contains 362 species and subspecies, a hypothetical list of 24 species, and a bibliography up to 1914.

1921-1940

Field book of birds of the southwestern United States.
Wyman, L. E. and E. F. Burnell. 1925.
Houghton Mifflin Co., Boston. 308pp.

Birds of New Mexico.
Bailey, F. M. 1928.
New Mex. Dept. Game and fish. 807pp.
*Incidental mention of habits and occurrence of several species of birds in Arizona.

Endemism and the American Northwest.
McCabe, T. T. 1936.
Wilson Bull. 48:289-302.
*Most of Arizona is included in the region of greatest endemism.

The faunal areas of Arizona, based on bird distribution.
Phillips, A. R. 1939.
M. S. thesis. Univ. Ariz. 62 pp.

1941-1960

Distribution of birds in relation to major biotic communities.
Pitelka, F. A. 1941.
Amer. Midland Nat. 25:113-137.
*Some Arizona species are included in the examples.

Birds of the Arizona desert.
Smith, G.T. 1941.
Doubleshoe Publishing, Scottsdale, Arizona.

Hunting in the southwest.
O'Connor, J. 1945.
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Relationships among 3 species of jays wintering in southeastern Arizona.
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*Observations were made on the individuals that fed the nestlings at 6 nests in 4 color-banded flocks.

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*An intensive study was conducted on the Harris' hawk (Parabuteo unicinctus superior) populations in Pima and Pinal Counties, Arizona [USA] from 1971-1973.

Coexistence of sparrows: a test of community theory.
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*The study, in grasslands of southeastern Arizona, supported the predictability of current community theory. For each of the habitats studied, the production of seeds and the abundances of seed-eating winter-resident sparrows was measured. The theory correctly predicted the number of species supported in each habitat. In both cases for which the prediction was that only one species could be supported, the theory correctly predicted which species should be present.

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Notes on the vocalizations of the Mexican chickadee.
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*Vocalizations of Mexican chickadees recorded in the Chiricahua Mountains, Arizona, are described with the aid of audiospectrograms.

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*Strickland's Woodpeckers (Picoides stricklandi) were studied in the pre-nesting and early nesting periods in the Chiricahua Mountains of Arizona. This woodpecker prefers to feed upon pines in the pre-nesting season, but is less selective during the nesting season. In contrast to earlier reports, an avoidance of, rather than a preference for oaks was found.

Reciprocal aid-giving in a communal bird.
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Do chipping sparrows forage optimally?
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*The abundances, weights, and handling times of all of the common seeds found in an oak woodland on The Research Ranch in southeastern Arizona were estimated in order to test the hypothesis that chipping sparrows maximize their rate of energy intake while foraging. Chipping sparrows do not

maximize their net rate of energy intake while foraging, but they come close to doing so.

The coppery-tailed trogon: Arizona's bird of paradise.
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*Personal observations of the elegant trogon are described

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>1980
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*Free-flying black-chinned hummingbirds (A. alexandri) at a site in southeastern Arizona [USA] were attracted to artificial feeders displaying narrow spectral bands of light (7 nm half band width). Results are consistent with a growing body of evidence suggesting that the color space of birds may be more than 3-dimensional.

Competition and the structure of an avian foraging guild.
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*Using data on microhabitat overlap the intensities of interspecific competition experienced by 7 spp. of foliage gleaning birds in a southeastern Arizona pine forest were estimated.

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*The bird populations of the Mapami Biosphere Reserve are summarized in terms of their respective structures and changes within seasons.

Notes on the body weight and molt of the elf owl (Micrathene whitneyi) in southeastern Arizona.
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North Am. Bird Band. 6:104-105.

Food supply, predation, and potential for competition between western and cassin's kingbirds.
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Flock size and the organization of behavioral sequences in juncos.
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*The sequential organization of scanning for approaching predators and pecking for food was investigated by analyzing films of yellow-eyed Juncos. For a given group size, the probability that a bird scans after each peck was found to be a constant. However, this probability decreased as flock size increased.

Apparent predation on horned lark by loggerhead shrike.
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Southwest. Nat. 27:367.

Vocalization and behavior of violet-green swallows Tachycineta thalassina in the Chiricahua Mountains Arizona USA.
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Vocalizations and behaviour of violet-green swallows in the Chiricahua Mountains, Arizona.
Brown, C. R. 1983.
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Communal harvesting of a transient food resource in the Mexican jay.
Brown, J. L. 1983.
Wilson Bull. 95:286-287.

Nocturnal moonlight calling by elegant trogon in Arizona.
Elliott, B.G. 1983.
West. Birds 14:53.

Differential usage of song types by plain, bridled and tufted titmice.
Gaddis, P. K. 1983.
Ornis. Scand. 14:16-23.

Overlap and competition in avian guilds.
Maurer, B. A. 1983.

Am. Nat. 121:903-907.

Ecological community theory and the coexistence of sparrows.
Pulliam, H. R. 1983.
Ecology 64:45-52.
*Ecological community theory attempts to predict the number and relative abundance of coexisting species of consumers based on resource use and availability. The observed patterns of species coexistence appear consistent with the Ecological Community Model based on resource abundance and aggressive interference. However, they are also consistent with coexistence based on interspecific partitioning by seed size.

Opportunistic foraging of western kingbirds on aggregations of tiger beetles.
Schultz, T.D. 1983.
Auk 100:496-497.
*The author observed the kingbirds feeding upon a pondside population of tiger beetles (Cicindela sedecimpunctata) during the peak abundance of the beetles around the pond.

Notes on the mist-netting of seven elf owls (Micrathene whitneyi) and two western screech-owls (Otus kennecotti) on 15 July 1982.
Walters, P.M. 1983.
North Amer. Bird Band. 8:13.

Resource use by sympatric kingbirds.
Blancher, P. J. and R. J. Robertson. 1984.
Condor 86:305-313.
*Resource use by Cassin's kingbirds (Tyrannus vociferans) and western kingbirds (T. verticalis) was studied during the breeding season in southeastern Arizona. The former nested predominantly in riparian creek habitat while the latter nested in more open desert habitat.

Nest parasitism by cowbirds on buff-breasted flycatchers, with comments on nest-site selection.
Bowers, R.K.,Jr. and J. B. Dunning Jr. 1984.
Wilson Bull. 96:718-719.
*The buff-breasted flycatcher (Empidonax fulvifrons) is a small flycatcher of the Mexican highlands which regularly breeds in limited numbers in the mountains of southeastern Arizona and southwestern New Mexico. Few details of its life history have been published. Nest parasitism by cowbirds has not been reported for this species. In the course of a general life history investigation of this flycatcher, the author established that brown-headed cowbirds (Molothrus ater) and probably bronzed cowbirds (M. aeneus) parasitize the nest of this species.

Light-breasted purple martins dominate dark-breasted birds in a roost: Implications for female mimicry.
Brown, C. R. 1984.
Auk 101:162-164.

Agonistic 'whirling' by zone-tailed hawks.
Clark, W. S. 1984.
Condor 86:488.

Similarity and apparent convergence in the nectar-sugar composition of some hummingbird-pollinated flowers.
Freeman, C. E., W. H. Reid, J. E. Becvar, and R. Scogin. 1984.
Botanical Gazette 145:132-135.
*The data, primarily from southwestern North America, define a range of nectar composition, possibly representing the preferences of hummingbirds. The data support assertations of adaptive convergence in the sugar composition of nectar in hummingbird-pollinated species.

Predation on sonoran spotted whiptails, Cnemidophorus sonorae (teiidae), by the great-tailed grackle, Quiscalus mexicanus (Icteridae).
Jennings, M. R. 1984.
Southwest. Nat. 29:514.

Habitat use by wintering birds of prey on southeastern Arizona.
Parker, R. E. and E. G. Campbell. 1984.
West. Birds 15:175-183.

Sexual dimorphism and parental role switching in gila woodpeckers.
Martindale, S. and D. Lamm. 1984.
Wilson Bull. 96:116-121.

Habitat use by wintering birds of prey on southeastern Arizona.
Parker, R. E. and E. G. Campbell. 1984.
West. Birds 15:175-183.

Phenotypic variation of the Mexican duck Anas platyrhynchos diazi in Mexico.
Scott, N. J. Jr. and R. P. Reynolds. 1984.
Condor 86:266-274.

Avian distribution patterns along a Sonoran Desert bajada.
VanderWall, S.B., and J.A. MacMahon. 1984.
J. Arid Environments 7:59-74.
*Avian population density, foraging behavior, nest selection, and other aspects of vegetation use are reported from the Organ Pipe Cactus National Monument.

Ecological correlates of group size in a communally breeding jay.
Brown, J. L. and E. R. Brown. 1985.
Condor 87:309-315.
*We studied local variation in size of social units in the Gray-breasted (or Mexican) Jay

(Aphelocoma ultramarina) throughout its elevation range in the Chiricahua Mountains, Arizona. At its lower limit (1,463 m), the ecological distribution of the species ended where oaks became rare, even though other large trees were present. The upper limit of distribution (2,103 m) coincided with the beginning of the area occupied by Steller's Jays (Cyanocitta stelleri), and not with a decrease in the number of species of Quercus or the availability of mast.

Spread-winged posture of turkey vultures Cathartes aura single or multiple function.
Clark, R. G. and R. D. Ohmart. 1985.
Condor 87:350-355.
*Turkey vultures appear to spread their wings for at least two reasons: (1) to dry features, and (2) to ameliorate the thermal gradient between themselves and their environment, although the two functions are not mutually exclusive.

Nesting doves and thrashers share close quarters.
Emlen, J. T. and R. R. Ogden. 1985.
West. Birds 16:98.

Changes in five-striped sparrow song in intra- and intersexual contexts.
Groschupf, K. 1985.
Wilson Bull. 97:102-106.
*The purpose of this study was to determine whether Five-striped Sparrow (Aimophila quinquestriata) note complex and song type use and delivery within songs and bouts were related to intra- or intersexual contexts.

Seasonal changes in the habitat distribution of transient insectivorous birds in southeastern Arizona: competition mediated?
Hutto, R.L. 1985.
Auk 102:120-132.
*The distribution and abundance of 26 migratory insectivorous birds were recorded over an elevational habitat gradient in the Chiricahua Mountains, Arizona for the spring and fall migratory season.

Avian community dynamics in desert grasslands: observational scale and hierarchical structure.
Maurer, B. A. 1985.
Ecological Monographs 55:296-312.
[see also: Maurer, B. A. 1984. Environmental heterogeneity and avian community structure in southeastern Arizona semidesert shrub-grassland. Ph.D diss., Univ. Arizona, Tucson]
*Peak bird densities and biomass in mesquite savannah communities occurred during May-June. Grassland communities achieved highest bird densities and biomass during July-August. This fluctuation corresponds to the nutritional value of forage being produced which in turn effects the insect population upon which the avian community relies.

Foraging efficiency, resource partitioning, and the coexistence of sparrow species.

Pulliam, H. R. 1985.
Ecology 66:1829-1836.
*Large species of sparrows were more efficient than small species at handling large seeds. Large and small sparrows were about equally efficient at handling small seeds. Different species of sparrows were likely to have broadly overlapping diets whenever seeds were scarce enough for the consumption of seeds by one species to have much impact on the availability of seeds to another species.

Winter habitats of sapsuckers in southeastern Arizona.
Bock, C.E. and D. L. Larson. 1986.
Condor 88:246-247.

Mobbing behavior of a pair of elegant trogons.
Cully, J.F., Jr. 1986.
Condor 88:103-104.

Weights of North American birds, Arizona sparrows.
Dunning, J. B., Jr., and R. K. Bowers, Jr. 1986.
N. Am. Bird Band. 11:59-60.
*Tables of weights and measurements of birds banded in Arizona, including many southeastern Arizona species.

Ecological distribution of the gray-breasted jay, Aphelocoma ultramarina, the role of habitat.
Edwards, T. C. Jr. 1986.
Condor 88:456-460.
*Habitat relationships of Gray-breasted Jays (Aphelocoma ultramarina) in southwestern New Mexico were investigated to determine what factors might account for the abrupt termination of this species' range. Results indicate that Gray-breasted Jays are tied closely to the densities of mast-producing tree species, and that not all sites seemingly capable of supporting jays are occupied.

Ecological distribution of the gray-breasted jay: The role of habitat.
Edwards, T.C., Jr. 1986.
Condor 88:456-460.
*Habitat relationship of Gray-breasted Jays (Aphelocoma ultramarina) in southwestern New Mexico were investigated to determine what factors might account for the abrupt termination of this species' range. Habitat variables at 38 sites along a 150 km north-south transect were measured and subjected to multivariate analysis. Patterns derived from this analysis were used to develop a discriminant function based on jay presence or absence. Results indicate that Gray-breasted Jays are tied closely to the densities of mast-producing tree species, and that not all sites seemingly capable of supporting jays are occupied.

Winter habitats of sapsuckers in southeastern Arizona.
Larson, D. L. and C. E. Bock. 1986.

Condor 88:246

Predicting habitat quality for grassland birds using density-habitat correlations.
Maurer, B. A. 1986.
J. Wildl. Manage. 50:556-566.
*The scale at which habitats are measured to develop regression models relating density to habitat features may be too coarse to account for significant variation among individual breeding pairs in a given area. Results of this study might raise questions regarding the use of qualitative models in monitoring and predicting the response of species to changes in their habitat. The implication of this study is that even quantitative models that make use of density data may not provide enough information to precisely evaluate and predict impacts on wildlife populations due to habitat alteration.

Niche expansion and contraction in a variable environment.
Pulliam, H. R. 1986.
Amer. Zool. 26:71-79.
*When food is abundant, sparrows are found in a great variety of habitats and appear to specialize on particularly profitable types of seeds. However, during periods of food scarcity, each sparrow occupies a very narrow range of habitats but consumes a great variety of seeds within each occupied habitat.

Hummingbird isolegs in an experimental system.
Rosenzweig, M. L. 1986.
Behav. Ecol. Sociobiol. 19:313-322.

Distribution-abundance relationships of some Arizona landbirds: a matter of scale?
Bock, C. E. 1987.
Ecology 68:124-129.
*The same species that were most abundant locally in the Huachuca Mountains of southeast Arizona were also most abundant on Christmas Bird Counts across Arizona and throughout the western United States. The positive correlation between distribution and abundance of winter landbirds appears to be an intrinsic property of the species themselves.

Social interactions and habitat overlap between plain and bridled titmice.
Gaddis, P. K. 1987.
Southwest. Nat. 32:197-202.

The influence of food supply on local density and diversity of sparrows.
Pulliam, H. R., and J. B. Dunning. 1987.
Ecology 68:1009-1014.
*Population densities of sparrows in southeastern Arizona grasslands are only limited during infrequent years of very low seed production.

Geographic variation in social structure and behavior of Aphelocoma ultramarina.
Strahl, S.D. and J. L. Brown. 1987.
Condor 89:422-424.
*The study of geographic variation in social structure may reveal flexibility of social behavior in a species and suggest correlations with environmental factors. The authors report observations on group size and composition from a population of A. u. couchii inhabiting the Chisos Mountains of Texas and compare them to published results for A. u. arizonae gathered using similar methods in the Chiricahua Mountains of Arizona. In addition, they describe a vocalization found in one population but not the other.

Carrying food items to cover for consumption: the behavior of ten bird species feeding under the risk of predation.
Valone, T. J. and S. L. Lima. 1987.
Oecologia 71:286-294.

Facultative migration in yellow-eyed juncos.
Horvath, E. G. and K. A. Sullivan. 1988.
Condor 90:482-484.
*The authors documented winter site fidelity and spring movements between the breeding and wintering grounds in a population of juncos in the Chiricahua Mountains, Cochise County, Arizona.

Diets of scaled quail in southern Arizona.
Medina, A.L. 1988.
J. Wildl. Manage.:753-757.
*The authors examined diets of scaled quail (Callipepla squamata) from 1982 to 1984 in southern Arizona. Seeds of forbs and woody plants composed >57% of the volume of quail diets. Forbs were staple foods and composed >39% of diets. Quail were most abundant in areas with low perennial grass cover and high forb cover.

Age-specific profitability and prey choice.
Sullivan, K. A. 1988.
Anim. Behav. 36:613-615.
*The author observed free-ranging flocks of juncos foraging on mealworms at six sites in the Chiricahua mountains of Arizona.

Informational constraints on optimally foraging hummingbirds.
Mitchell, W. A. 1989.
Oikos 55:145-154.

Dispersal of viable saguaro seeds by white-winged doves Zenaida asiatica.
Olin, G., S. M. Alcorn, and J. M. Alcorn. 1989.
Southwest. Nat. 34:281-284.

Ontogeny of time budgets in yellow-eyed juncos: adaptation to ecological constraints.
Sullivan, K. A. 1989.
Ecology 69:118-124.

Measuring patch assessment abilities of desert granivores.
Valone, T. J. and J. S. Brown. 1989.
Ecology 70:1800-1810.

Nest attentiveness and egg temperature in the yellow-eyed junco.
Weathers, W. W. and K. A. Sullivan. 1989.
Condor 91:628-633.
*The junco's nest attentiveness pattern appears to be a compromise between two conflicting selection pressures-nest predation and egg cooling.

Comparative age and sex ratios in Gambel's white-crowned sparrows in relation to year and latitude.
Barrentine, C. D., C. E. Corchran, M. W. Lincoln, L. R. Mewaldt, and P. M. Walters. 1990.
N. Am. Bird Band. 15:57-60.

Bats in spotted owl pellets in southern Arizona.
Duncan, R. B. and R. Sidner. 1990.
Great Basin Nat. 50:197-200.

Lethal temperatures in ash-throated flycatcher nests located in metal fence poles.
Dunning, J. B. Jr. and R. K. Bowers. 1990.
J. Field Ornithol. 61:98-103.
*Nesting in metal fence poles has allowed the ash-throated flycatcher to expand its breeding range locally into areas where natural cavities are absent; however, breeding pairs using these nest sites appear to suffer low nest success due directly or indirectly to high nest temperatures.

Galapagos and Harris' hawks: divergent causes of sociality in two raptors.
Faaborg, J. and J. C. Bednarz. 1990.
In Stacey, P. B. and W. D. Koenig (eds). Cooperative breeding in birds: long-term studies of ecology and behaviour. Cambridge Univ. Press, New York.

Vocal repertoire of the mexican chickadee. 2. Song and song-like vocalizations.
Ficken, M. S. 1990.
J. Field Ornithol. 61:388-395.

Vocal repertoire of the mexican chickadee. 1. Calls.
Ficken, M.S. 1990.
J. Field Ornithol. 61:380-387.

Predation on yellow-eyed junco nestlings by twin-spotted rattlesnakes.

Gumbart, T. C. and K. A. Sullivan. 1990.
Southwest. Nat. 35:367-368.

Acorn woodpeckers; group-living and food storage under contrasting ecological conditions.
Koenig, W.D. and P. B. Stacey. 1990.
Pages 413-453 in: Stacey, P.B. and Koenig, W.D. (eds). Cooperative breeding in birds: long-term studies of ecology and behaviour. Cambridge University Press, New York.
*Individual colonies of acorn woodpeckers may have chosen group living and mate sharing for different reasons, including environmental constraints to dispersal (all territories occupied) as well as benefits to remaining high-quality territory.

Differences in the foraging behavior of individual gray-breasted jay flock members.
McKean, L.M. 1990.
Studies Avian Biol. No. 13:284-287.

The importance and consequence of temporal variation in avian foraging behavior.
Miles, D. B. 1990.
Stud. Avian Biol. No. 13:210-217.

Habitat movements and roost characteristics of Montezuma quail in southeastern Arizona USA.
Stromberg, M. R. 1990.
Condor 92:229-236.
*Movements, survivorship, covey size, roosting behavior, and habitat use of Montezuma Quail (Cyrtonyx montezumae) marked with radio transmitters were studied in the foothills of the Huachuca Mountains of southeastern Arizona from October 1986 through November 1987. Coveys used small areas (0.09-6 ha) and during midwinter, the same small area would be used for long periods. In late winter and early spring, coveys occupied much larger areas by sequentially spending 3-10 days on adjacent, nonoverlapping areas as large as 50 ha. When compared to randomly selected points in the oak savanna habitat, quail preferred southeast-facing hillsides in tall grasses for night roosts. Day-use areas were selectively on north-facing hillsides. Areas used by quail during the day were generally on hillsides, about 16 m from the nearest oak tree and had grass cover intermediate between barren areas under oak trees and more dense grass cover farther away from the oaks.

Hummingbird sweetness preferences: taste or viscosity?
Stromberg, M. R., and P. B. Johnsen. 1990.
Condor 92:606-612.
*Black-chinned hummingbirds responded to decreased sucrose concentrations by increasing sampling behavior at feeders; at increased sucrose levels, sampling behavior decreased. Chemosensory mechanisms rather than physical measures of viscosity are responsible for the sensory evaluation and the subsequent selection of sucrose nectars.

Bird species distribution patterns in riparian habitats in southeastern Arizona.
Strong, T. R., and C. E. Bock. 1990.

Condor 92:866-885.
[see also: Strong, T. R. 1987. Riparian bird populations of the Huachuca Mountains and vicinity, southeastern Arizona. Ph.D diss., Univ. Colorado, Boulder]
*Cottonwood vegetation had the greatest bird species richness, and both cottonwood and sycamore areas had high total bird density during the breeding season. Upland vegetation was more important during winter, and plots in open grassland areas had greater species richness and density. Widespread, abundant species in the Huachuca Mountains were also widespread and abundant in the western U.S.

Dominance hierarchies and helper contributions in Harris' Hawks.
Dawson, J. W. and R. W. Mannan. 1991.
Auk 108:649-660.
*We examined dominance hierarchies, mating relationships, and helping by individually marked Harris' Hawks (Parabuteo unicinctus) at 64 nests in Arizona (1984-1988).

The role of territoriality in the social organization of Harris' Hawks.
Dawson, J. W. and R. W. Mannan. 1991.
Auk 108:661-672.
*We studied territoriality and sociality in a population of Harris' Hawks (Parabuteo unicinctus) in Arizona during breeding and nonbreeding periods from 1984 to 1986. We propose that water, an important resource during the summer, may represent an ecological constraint that favors group living in Harris' Hawks in the Sonoran Desert.

Unusual behavior in a solitary vireo.
Kuzmann, M. R. and R. R. Johnson. 1991.
Wilson Bull. 103:309-310.

Lucy's warbler banding in southeastern Arizona.
Lamm, D. W. 1991.
N. Am. Bird Band. 16:9-10.

Intruders on yellow-eyed junco territories.
Leary, J. and K. A. Sullivan. 1991.
Wilson Bull. 103:292-295.

Energy, predators and the behavior of feeding hummingbirds.
Lima, S. L. 1991.
Evol. Ecol. 5:220-230.

Predators and avian community organization: an experiment in a semi-desert grassland.
Lima, S. L., and T. J. Valone. 1991.
Oecologia 86:105-112.
*As cover increases, species with cover-dependent escape tactics also increase, while cover-

independent species decrease greatly. Some cover-independent species may actively avoid cover-rich areas.

Northern harrier attacks Cooper's hawk.
Sandell, C. I. 1991.
New Mexico Ornithol. Soc. Bull. 19:9.

Bayesian and prescient assessment: foraging with pre-harvest information.
Valone, T.J. 1991.
Animal Behaviour 41:569-577.
*Inca doves feeding in artificial resource patches exploited the patches in a manner consistent with prescient foraging when patch quality was temporarily predictable. The same individuals exploited patches in a manner consistent with Bayesian foraging when prescient foraging would not be likely because patch quality was temporally unpredictable.

Foraging efficiency of parent Juncos and their young.
Weathers, W. W. and K. A. Sullivan. 1991.
Condor 93:346-353.

Energy expenditure and juvenile foraging efficiency: A major constraint on passerine reproductive success.
Weathers, W. W. and K. A. Sullivan. 1991.
In Bell, B. D. et al. (eds.), Acta 20 Congressus Internationalis Ornithologici. Christchurch, vol. 4, New Zealand, Ornithological Congress Trust Board, Wellington.

Annual molts and interruption of the fall migration for molting in lazuli buntings.
Young, E. 1991.
Condor 93:236-250.
*Lazuli Buntings, Passerina amoena, interrupt their fall migration in the American Southwest to undergo the major portion of their fall molt.

Effects of bird predation on grasshopper densities in an Arizona grassland.
Bock, C. E., and M. C. Grant. 1992.
Ecology 73:1706-1717.
Birds clearly limited grasshopper abundance in grasslands, but this had no appreciable impact on vegetative cover or grass species composition.

Is there competition between exotic and native cavity-nesting birds in the Sonoran Desert: an experiment.
Bibles, B.D. 1992.
Ph.D diss., Univ. of Arizona, Tucson.
*Near Tucson.

Habitat associations of birds and herptofauna in southeastern Arizona.
Block, W.M., and K.E. Severson. 1992.
Pages 55-57 in Chiricahua Mountains Research Symposium Proceedings, Southwest Parks and Monuments Association, Tucson.
*The study evaluated the habitat associations of birds in the mountains in southeastern Arizona.

Use of oaks by neotropical migratory birds in the southwest.
Block, W.M., J.L. Ganey, K.E. Severson, and M.L. Morrison. 1992.
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USDA Forest Service Gen. Tech. Rep. RM-215.
*The types, general distributions, and macrohabitat associations of neotropical migratory birds are examined.

Field experimental evidence for diffuse competition among southwestern riparian birds.
Bock, C. E., A. Cruz, M. C. Grant, C. S. Aid, and T. R. Strong. 1992.
American Naturalist 140:815-828.
*Open-nesting bird species decreased in abundance and cavity-nesting species increased after nest boxes were added in 50 experimental areas, as compared to an equal number of control areas. This indicated that community-wide (diffuse) competition is an important factor influencing the distribution and abundance of birds in riparian ecosystems.

A long term study of the Mexican jay in the Chiricahua Mountains.
Brown, J.L., and E.R. Brown. 1992.
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*The behavior and ecology of the Mexican jay was reported after 25 years of study. Longevity, reproduction, dispersal, mating system, and sociality were described.

A preliminary understanding of Mexican spotted owl habitat and distribution in the Chiricahua Mountains and associated sub-Mogollion Mountain Ranges in southeastern Arizona.
Duncan, R.B., and J.D. Taiz. 1992.
Pages in 58-61 in Chiricahua Mountains Research Symposium Proceedings. Southwest Parks and Monuments Association, Tucson.
*A review of Mexican spotted owl habitat and distribution in southeastern Arizona.

Use of oak and associated woodlands by Mexican spotted owls in Arizona.
Ganey, J.L., R.B. Duncan, and W.M. Block. 1992.
Pages 125-128 in Ffolliott, P.F., G.J. Gottfried, D.A. Bennett, V.M. Hernandez C., A. Ortega-Rubio, and R.H. Hamre, technical coordinators. Ecology and management of oak and associated woodlands: perspectives in the southwestern United States and northern Mexico. USDA For. Serv. Gen. Tech. Rep. RM-218.

*In Arizona, Mexican spotted owls are year-round residents of the Madrean oak-pine forests, encinal woodlands, and ponderosa pine-gambel oak forests, while some spotted owls winter in pinyon-juniper woodlands.

Food storing by Mexican chickadees and Bridled Titmice.
Hampton, R. R. and D. F. Sherry. 1992.
Auk 109:665-666.

Biology of North American accipters in the Chiricahua Mountains.
Snyder, N.F.R., and H.A. Shyder. 1992.
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*Three species of hawks are discussed in reference to their biology and habitat requirements.

Information for patch assessment: A field investigation with black-chinned hummingbirds.
Valone, T.J. 1992.
Behav. Ecol. 3:211-222.
*Hummingbirds apparently combine prior information on the distribution of resources within patches with current patch sampling to increase foraging efficiency. Individuals using prior information foraged more efficiently than those that did not.

The eared trogon in Arizona: behavior, ecology, and management.
Williamson, S.L. 1992.
Pages 98-101 in Chiricahua Mountains Research Symposium Proceedings. Southwest Parks and Monuments Association, Tucson.
*Sighting of the eared trogon in the Miller Peak Wilderness of the Coronado National Forest is discussed.

Fauna silvestre de la unidad forestal no. 6 El Salto, Durango, Mexico.
Aguilar-Valdez, B.C., R. Miranda-Salazar, and S.G. Salazar-Hernandez. 1993.
In Fernandez-S., and C. Aguirre-C. (compilers), Curso sobre manejo integral de fauna silvestre en ecosistemas forestales.
Instituto Technologico Forestal no. 1, El Salto, Durango, Mexico.
*Lists important wildlife species found in the forests of the Sierra Madre Mountains, with brief descriptions of their characteristics and habitat requirements.

'Tool' use by the red-tailed hawk (Buteo jamaicensis).
Ellis, D. H. and S. Brunson. 1993.
J. Raptor Res. 27:128.

Immature red-tailed hawk captures Montezuma quail.
Holdermann, D.A. and C. E. Holdermann. 1993.
New Mexico Ornithol. Soc. Bull. 21:31-33.

A comparison of home range estimates for a bald eagle wintering in New Mexico.
Stahlecker, D. W. and T. G. Smith. 1993.
J. Raptor Res. 27:42-45.

Suppression of saguaro cactus flower-bud formation by roosting vultures in Arizona.
Bennett, P. S., and M. R. Kunzmann. 1994.
Southwestern Nat. 39:200-203.
*Found only localized problems.

Field metabolic rate and food consumption of two sympatric hummingbird species in southeastern Arizona.
Powers D. R. and T. M. Conley. 1994.
Condor 96:141-150.
*We compared the field metabolic rate (FMR) and behavior around sugar-water feeders of sympatric territorial and non-territorial hummingbirds in the Chiricahua Mountains of southeastern Arizona during July 1987 and 1989.

Breeding

1800s
Nest, eggs and breeding habits of the Vermilion Flycatcher (Pyrocephalus cephalus rubineus var. Mexicanus).
Bendire, C. E. 1873.
Amer. Nat. 7:170-171.
*In southern Arizona.

Breeding habits of Geococcyx californianus.
Bendire, C. E. 1878.
Bull. Nuttall Ornith. Club 3:39.
*Twenty nests found in southern Arizona in 1872.

Nest and eggs of the Painted Flycatcher (Setophaga picta).
Bryant, W. E. 1881.
Bull. Nuttall Ornith. Club 6:176-177.
*From the santa Rita Mountains.

Notes on a collection of birds' nests and eggs from southern Arizona Territory.
Bendire, C. E. 1887.
Proc. U.S. Nat. Mus. 10:551-558.
*Eight species from the vicinity of Fort Huachuca.

Trogon ambiguus breeding in Arizona.

Ridgway, R. 1887.
Proc. U.S. Nat. Mus. 10:147.
*In the Huachuca Mountains.

The Coppery-tailed Trogon (Trogon ambiguus) breeding in southern Arizona.
Ridgway, R. 1887.
Auk 4:161-162.
*In the Huachuca Mountains.

Nesting of the Red-faced Warbler (Cardellina rubrifrons) in the Huachuca Mountains, southern Arizona.
Price, W. W. 1888.
Auk 5:385-386.

Notes on Pipilo fuscus mesoleucus and Pipilo aberti, their habits, nests and eggs.
Bendire, C. E. 1890.
Auk 7:22-29.

Nesting of the Arizona Jay.
Poling, O. C. 1890.
Ornith. and Ool. 15:139.
*In the Huachuca Mountains.

On the nesting habits and eggs of the Vermilion Flycatcher.
Poling, O. C. 1890.
Ornith. and Ool. 15:140.
*Near Fort Huachuca.

The nest and eggs of the Olive Warbler (Dendroica olivacea).
Price, W. W. 1895.
Auk 12:17-19.
*Observations in the Huachuca, Chiricahua, Graham and White Mountains.

Coues' Flycatcher.
Breninger, G. F. 1897.
Osprey 2:12.
*A nest in the Huachuca Mountains.

A nest of the Blue-throated Hummingbird.
Breninger, G. F. 1899.
Osprey 3:86.
*In the Huachuca Mountains.

Notes on Eugenes fulgens.
Willard, F. C. 1899.
Osprey 3:65-66.
*Nesting in the Huachuca Mountains.

1900-1920
Nesting of the Rivoli Hummingbird in southern Arizona.
Howard, O. W. 1900.
Condor 2:101-102.
*In the Huachuca Mountains.

Nesting of the Prairie Falcon.
Howard, O. W. 1902.
Condor 4:57-59.
*In the Huachuca Mountains, Arizona.

Nests and eggs of Coeligena clemenciae.
Breninger, G. F. 1903.
Auk 20:435.
*In the Huachuca Mountains.

Eggs of the Olive Warbler (Dendroica olivacea).
Childs, J. L. 1905.
The Warbler, 2nd ser.1:17;pl.I.
*From the Huachuca Mountains.

Nest and eggs of the Blue-throated Hummingbird (Coeligena clemenciae).
Childs, J. L. 1906.
The Warbler 2:65;pl.IV.
*From the Huachuca Mountains.

An Arizona nest census.
Willard, F. C. 1908.
Condor 10:44-45.
*Brief accounts of the nesting of 14 species of birds at Tombstone.

Huachuca notes.
Willard, F. C. 1908.
Condor 10:206-207.
*Elevations of nests of some species of birds differ on the east and west sides of the range.

Three Vireos: nesting notes from the Huachuca Mountains.
Willard, F. C. 1908.

Condor 10:230-234.

Nesting of the Arizona Junco.
Willard, F. C. 1909.
Condor 11:129-131.
*In the Huachuca Mountains.

The Flammulated Screech Owl.
Willard, F. C. 1909.
Condor 11:199-202.
*Breeding in the Huachuca Mountains.

Nesting of the Western Evening Grosbeak (Hesperiphona vespertina montana).
Willard, F. C. 1910.
Condor 12:60-62.
*In the Santa Catalina and Huachuca mountains.

The Olive Warbler (Dendroica olivacea) in southern Arizona.
Willard, F. C. 1910.
Condor 12:104-107.
*Observations on nesting.

The Blue-throated Hummingbird.
Willard, F. C. 1911.
Condor 13:46-49.
*Breeding in the Huachuca Mountains.

Breeding of the Scott Sparrow.
Willard, F. C. 1912.
Condor 14:195-196.
*In the Huachuca Mountains.

Nesting of the Rocky Mountain Nuthatch.
Willard, F. C. 1912.
Condor 14:213-215.
*In the Huachuca Mountains.

Some late nesting notes from the Huachuca Mountains, Arizona.
Willard, F. C. 1913.
Condor 15:41.

Late nesting of certain birds in Arizona.
Willard, F. C. 1913.

Condor 15:227.
*Observations on 7 species in the Huachuca Mountains.

Sharp-shinned Hawk nesting in Arizona.
Willard, F. C. 1913.
Condor 15:229.
*In the Huachuca Mountains.

Breeding of the Bronzed Cowbird in Arizona.
Gilman, M. F. 1914.
Condor 16:255-259.

The Golden Eagle in Cochise County, Arizona.
Willard, F. C. 1916.
Ool. 33:3-8.
*Notes on nesting, with photographs.

Nesting of the Band-tailed Pigeon in southern Arizona.
Willard, F. C. 1916.
Condor 18:110-112.
*In the Huachuca Mountains.

Evidence that many birds remain mated for life.
Willard, F. C. 1918.
Condor 20:167-170.
*Gives many Arizona examples.

1921-1940
Some unusual nesting sites of several Arizona birds.
Willard, F. C. 1923.
Condor 25:121-125.

The Mexican Cliff Swallow in Cochise County, Arizona.
Willard, F. C. 1923.
Condor 25:138-139.
*Nesting at Fort Huachuca.

The Buff-breasted Flycatcher in the Huachuchas.
Willard, F. C. 1923.
Condor 25:189-194.
*Nest and eggs collected in May 1907.

Discovery of a nest and eggs of the Blue-throated Hummingbird.

Ray, R. C. 1925.
Condor 27:49-51.
*In the Huachuca Mountains.

Elf Owls.
Kimball, H. H. 1935.
*At Tucson and the Chiricahua Mountains; sets never contain more than three eggs.

Nesting of the Black Hawk in Arizona.
Monson, G. 1936.
Wilson Bull. 48:313-314.
*In Arivaipa Canyon.

Notes on nesting and other habits of the Western White-winged Dove in Arizona.
Neff, J. A. 1940.
Jour. Wildl. Mgmt. 4:279-290.

1941-1960

An Arizona nest of the Coppery-tailed Trogon.
Allen, A. A. 1944.
Auk 61:640-642.
*In the Santa Rita Mountains.

Trailing desert owls.
Carr, W. H. 1947.
Nat. Hist. 56:468-473.
*Notes on nesting of Great Horned Owls in southern Arizona.

Arizona Junco.
Peterson, R. T. 1948.
Wilson bull. 60:5, with frontispiece of Arizona Junco in color.
*Brief notes on habits and relationships.

Nesting of the Mexican Jay in the Santa Rita Mountains, Arizona.
Gross, A. O. 1949.
Condor 51:241-249.
*Extensive notes on nest building, incubation, and growth of young.

Nesting of Mearns Quail in southeastern Arizona.
Wallmo, O. C. 1954.
Condor 56:125-128.

Hooded Oriole nesting under eaves of house.

Stophlet, J. J. 1958.
*Near Tombstone, Arizona.

Adaptation of breeding schedule to latitude.
Miller, A. H. 1960.
[In] Proc. 12th Int. Ornith. Cong. 2:513-522.
*In Arizona: Cyrtonyx montezumae and Amphispiza bilineata are discussed.

Thick-billed Kingbird nesting in New Mexico.
Zimmerman, D. A. 1960.
Auk 77:92-94.
*Three pairs observed in the Arizona portion of Guadalupe Canyon, Cochise County, Arizona.

1961-1980
Breeding of Botteri's Sparrow (Aimophila botterii) in Arizona.
Ohmart, R. D. 1968.
Condor 70:277.
*At Ophir Gulch, Santa Rita Mountains, Pima County, Arizona.

Chronology of the nesting season of White-winged Doves Zenaida asiatica mearnsi (Ridgway) in Arizona.
Stair, J. L. 1970.
M. S. thesis. Univ. Ariz. 69 pp.

Notes on the nesting of the Black-bellied Tree duck near Phoenix, Arizona.
Johnson, A. R. and J. C. Barlow. 1971.
Southwest. Nat. 15:394-395.

Notes on the breeding of the sulfur-bellied flycatcher in Arizona.
Ligon, J. D. 1971.
Condor 73:250-252.

Nesting of mourning doves at San Simon Cienga, southwestern New Mexico.
Davis, C.A., and G.K. Sintz. 1973.
Agricultural Experiment Station Research Report 265, New Mexico State Univ., Las Cruces.
*Nesting of mourning doves.

Experimental study of feeding rates of nesting Cooper's hawks.
Snyder, N. F. and H. A. Snyder. 1973.
Condor 75:461-463.

Green cones of the pinon pine stimulate late summer breeding in the pinon jay.
Ligon, J. D. 1974.

Nature 250:80-82.
*Reports field and experimental evidence that in south-western New Mexico, reproductive activity of Gymnorhinus cyanocephalus is triggered in late summer and autumn by the presence of large quantities of green cones of Pinus edulis. The cones indicate that adequate food, in the form of pinon seeds, will be available to young birds in the winter.

Nesting peregrine falcons in the Gila National Forest, New Mexico, 1977: behavior and ecology.
Eberhardt, K. C. and R. W. Skaggs. 1977.
Chihuahuan Desert Res. Inst., Contribution 39. 43pp.
*Three peregrine falcon (Falco peregrinus) eyries in the Gila National Forest, New Mexico were monitored for a year. Observations were made on 13 individual peregrines, including seven young that fledged from the two eyries occupied by adult pairs. It is recommended that peregrine prey species should be analyzed for pesticide residues and heavy metals and that trailbikers and low-flying aircraft should be restricted from the nesting area.

Factors influencing reproductive success and population densities in Montezuma quail.
Brown, D.E. 1979.
J. Wildl. Manage. 43:522-526.

Acceptance and rejection of parasitic eggs by the road-runner female Geococcyx californianus and the gambel's quail female Lophortyx gambeli.
Eltaher, H. 1980.
J. Coll. Sci. Univ. Riyadh 11:85-94.

>1980
An observation of copulation and allopreening of a pair of whiskered owls.
Smith, D. G., A. Devine, and D. Gendron. 1982.
J. Field Ornithol. 53:51-52.

Possible cases of infanticide by immigrant females in a group-breeding bird.
Stacey, P.B. and T. C. Edwards Jr. 1983.
Auk 100:731-733.

Nest parasitism by cowbirds on buff-breasted flycatchers, with comments on nest-site selection.
Bowers, R.K., Jr. and J. B. Dunning Jr. 1984.
Wilson Bull. 96:718-719.
*The buff-breasted flycatcher (Empidonax fulvifrons) is a small flycatcher of the Mexican highlands which regularly breeds in limited numbers in the mountains of southeastern Arizona and southwestern New Mexico. Few details of its life history have been published. Nest parasitism by cowbirds has not been reported for this species. In the course of a general life history investigation of this flycatcher, the author established that brown-headed cowbirds (Molothrus ater) and probably bronzed cowbirds (M. aeneus) parasitize the nest of this species.

Cave swallow paired with cliff swallows.
Huels, T.R. 1985.
Condor 87:441-442.

Distribution, habitat, and breeding biology of the Botteri's sparrow.
Webb, E. A. 1985.
M.A. thesis, Univ. of Colorado, Boulder.
*Botteri's sparrow are tall-grass specialists that breed in small, isolated colonies in several types of semi-desert grassland and oak woodland in southeastern Arizona. They are most common in relatively undisturbed Sacaton grassland. They nest following the commencement of summer rains (July). This is in response to a bloom of grasshoppers, their primary summer food source. The breeding cycle is short with high nestling mortality. Their populations appeared stable.

Nesting success and productivity of hummingbirds in southwestern New Mexico and southeastern Arizona.
Baltosser, W. H. 1986.
Wilson Bull. 98:353-367.

Nesting success and productivity of hummingbirds in southwestern New Mexico and southeastern Arizona USA.
Baltosser, W. H. 1986.
Wilson Bull. 98:353-367.
*Predation was the major source of nest failure for hummingbirds studied in southwestern New Mexico and southeastern Arizona, accounting for nearly 80% of all failed nest attempts. Predation on eggs was responsible for just over 70% of all losses attributed to predation; predation on nestlings accounted for <30% of the losses. Nest failures resulting from abandonment, structural failure, and infertility were low and similar to that found in other studies dealing with altricial young.

Effect of food supply on the breeding biology of western kingbirds.
Blancher, P.J. and R. J. Robertson. 1987.
Ecology 68:723-732.
*The author studied the breeding ecology and behavior of Western Kingbirds in relation to abundance of flying insects in an area of sympatry with Cassin's Kingbirds in southeastern Arizona. Kingbirds did not appear to reduce significantly the local abundance of flying insects, which calls in question the importance of competition for food in determining local habitat separation.

Observations on the nesting success of Bell's vireos in southern Arizona.
Clark, C. F. 1988.
West. Birds 19:117-120.

Nest characteristics and nestling development of Cassin's and Botteri's sparrows in southeastern Arizona.
Maurer, B. A., E. A. Webb, and R. K. Bowers. 1989.

Condor 91:736-738.
*In southeastern Arizona, the Cassin's Sparrow (A. cassinii) and the Botteri's Sparrow (A. botterii) breed together in similar habitats. Nest placement, nest size, clutch size, and nestling development were studied to provide some insight into the ecological adaptations of each species. This paper compares aspects of the nesting biology of these two species in an area where they occur sympatrically and examines the possible significance that the patterns of interspecific variation have for the ecological and evolutionary relationships between the species.

Mexican jays: uncooperative breeding.
Brown, J. L. and E. R. Brown. 1990.
Pages 267-288 in Stacey, P. B. and W. D. Koenig (eds.), Cooperative breeding in birds: Long-term studies of ecology and behaviour. Cambridge Univ. Press, New York.

Dominance hierarchies and helper contributions in Harris' hawks
Dawson, J. W. and R. W. Mannan. 1991.
Auk 108:649-660.
*We examined dominance hierarchies, mating relationships, and helping by individually marked Harris' Hawks (Parabuteo unicinctus) at 64 nests in Arizona (1984-1988).

Plasma luteinizing-hormone, steroid-hormones, behavioral role, and nest stage in cooperatively breeding Harris' hawks.
Mays, N. A., C. M. Vleck, and J. Dawson. 1991.
Auk 108:619-637.

Growth and energetics of nestling yellow-eyed juncos.
Weathers, W. W. and K. A. Sullivan. 1991.
Condor 93:138-146.

Brood size and thermal environment influence field metabolism of nestling yellow-eyed juncos.
Sullivan, K. A. and W. W. Weathers. 1992.
Auk 109:112-118.

CONSERVATION AND MANAGEMENT

Grazing

1900-1920
The conditions governing bird life in Arizona.
Brown, H. 1900.
Auk 17:31-34.
*Blames overgrazing for causing widespread faunal changes; these changes were made much worse by the severe drought of 1892-93. The distribution and nesting habits of several species were

changed as a result.

>1980

Effects of livestock grazing on Mearns quail Cyrtonyx montezumae mearnsi in southeastern Arizona.
Brown, R. L. 1982.
J. Range Manage. 35:727-732.
*Grazing by domestic livestock does not limit production of food supplies for Mearns quail (C. m. mearnsi) in southeastern Arizona. Grazing available forage in excess of 55% by weight can nearly eliminate local quail populations by removing their escape or hiding cover just prior to the nesting season. This eliminates the breeding population itself. The 46-50% level of utilization by weight appears to be marginal for maintaining optimum quail populations.

Effects of long term livestock exclusion in a semiarid grassland.
Bock, C. E., and J. H. Bock. 1984.
Pages 123-133 in P. G. Rowlands, C. VanRiper III, and M. K. Sogge, eds., First conference proceedings on research in Colorado Plateau National Parks. USDI National Park Service, Center for Colorado Plateau Studies, Northern Arizona Univ., Flagstaff.
*Montezuma quail, Cassin's sparrow, Botteri's sparrow, and grasshopper sparrow were common breeding birds on ungrazed areas, whereas scaled quail, horned larks, and lark sparrows were the most abundant nesting species on grazed lands. Canopy cover of perennial grasses was higher on ungrazed areas.

Responses of birds, rodents, and vegetation to livestock exclosure in a semidesert grassland site.
Bock, C. E., J. H. Bock, W. R. Kenney, and V. M. Hawthorne. 1984.
J. Range Management 37:239-242.
*A protected upland site (ungrazed) supported 45% more grass cover, a comparatively mixed group of grass species, and four times as many shrubs as an adjacent grazed site. The grazed area supported a significantly higher number of birds during summer, whereas numbers did not differ between sites during winter.

Birds as grazing indicator species in southeastern Arizona.
Bock, C.E. and B. Webb. 1984.
J. Wildl. Manage. 48:1045-1049.
*Managers of national forests and rangelands are required, through the National Forest. Management Act, to identify and monitor wildlife "indicator species", whose populations "are believed to indicate effects of management activities on other species of a major biological community". Horned larks (Eremophila alpestris), Cassin's sparrows (Aimophila cassinii), and grasshopper sparrows (Ammodramus savannarum) are abundant summer birds in the semidesert grasslands of southeastern Arizona. The authors compared densities and habitats of these species on grazed vs. ungrazed sites.

Regrazing to benefit watershed-wildlife-livestock.
Anderson, E.W., D.L. Franzen, and J.E. Melland. 1990.

Rangelands 12:105-111.

Livestock-wildlife coordination in the encinal oak woodlands: Coronado National Forest.
Allen, L. S. 1992.
USDA For. Serv. Gen. Tech. Rep. RM-218:109-110.
*History of livestock management in southeast Arizona is presented. Needs for coordination of management are recommended.

Cover of perennial grasses in southeastern Arizona in relation to livestock grazing.
Bock, C. E., and J. H. Bock. 1993.
Conservation Biology 7:371-377.
*Total grass canopy cover was greater on ungrazed grasslands. Eight bunchgrass species grew taller on ungrazed areas; two short stoloniferous species were the only taxa substantially more abundant on grazed areas. Livestock grazing appeared to be an exotic ecological force that was destructive of certain components of the native flora and fauna.

Fire

1941-1960
Land use and native birds of Arizona.
Marshall, J. T., Jr. 1960.
Ariz. Acad. Sci. 2:75-77.
*Advocates controlled burning of grass and forest litter to improve water capture and open the forest stands.

1961-1980
Fire and birds in the mountains of southern Arizona.
Marshall, J. T., Jr. 1963.
[In] Proc. 2nd Ann. Tall Timbers Fire Ecology Conf. March 14-15, 1963, pp. 134-142.

Land use and native birds of Arizona.
Marshall, J. T., Jr. 1963.
Ariz. Cattlelog 19(6):14-15.
*Advocates controlled burning to promote grass and water capture.

Response of birds, small mammals, and vegetation to burning of sacaton grassland in southeastern Arizona.
Bock, C. E., and J. H. Bock. 1978.
J. Range Management 31:296-300.
*Fire appeared to benefit indigenous plants and wildlife of sacaton communities, as long as a mosaic of different aged stands were maintained. Burning reduced the height and extent of sacaton itself, and stimulated growth of other grasses and forbs. Summer fires created more bare ground and

encouraged a greater density and variety of annuals than winter fire; bird populations were greatly increased as a result of summer fires; total small mammal populations were reduced, however.

>1980

Changes in breeding bird density after prescribed burning in an Arizona semidesert grassland.
Aid, C. S. 1990.
M.A. Thesis, Univ. of Colorado, Boulder.

Grassland birds in southeastern Arizona: impacts of fire, grazing, and alien vegetation.
Bock, C. E., and J. H. Bock. 1988.
In P. Goriop, ed., Ecology and conservation of grassland birds. Tech. Publ. No. 7, International Council for Bird Preservation, Cambridge, England.
*Twenty-five bird species are common in the grasslands of southeastern Arizona. Burning temporarily increases herb growth and seed production, especially in Sacaton grassland. Doves, quail, and sparrows respond positively to these changes. Lovegrasses (Eragrostis spp.) are native to Africa and have been planted in Arizona in an attempt to revegetate degraded rangelands. Compared to ungrazed native grasslands, these plantations are ornithologically sterile, probably because they produce fewer seeds and insects. Dominant birds on ungrazed areas are grassland specialists, while common species on grazed lands are those typical of relatively open and xeric areas. Cassin's and grasshopper sparrows are the most abundant upland breeding birds on ungrazed areas; they are uncommon on heavily-grazed pastures. The Botteri's sparrow is a Sacaton specialist.

Effects of fire on wildlife in southwestern lowland habitats.
Bock, C. E., and J. H. Bock. 1990.
Pages 50-64 in J. S. Krammes, technical coordinator. Effects of fire in management of southwestern natural resources.
USDA Forest Service General Technical Report RM-191.
*Prescribed burning can benefit most wildlife in semidesert grasslands, especially if it is used to create fine-scale mosaics of native vegetation, including some unburned stands. Fire is likely to negatively affect vegetation and wildlife in Sonoran desert scrub, Chihuahuan Desert grassland, and riparian woodland.

Effects of prescribed fire on snags and cavity-nesting birds in southeastern Arizona pine forests.
Horton, S.P., and R.W. Mannan. 1988.
Wildlife Soc. Bull. 16:37-44.
*This study compared the number and characteristics of dead trees before and after broadcast, understory fires in a ponderosa pine forest; to describe snags used by birds for nesting and compare the availability of similar snags before and after prescribed fires; and to compare breeding populations of cavity-nesting birds before and after the fires to identify species that were affected in the first year after treatment.

Increasing habitat diversity in southwestern forests and woodlands via prescribed fire.
Severson, K.E., and J.N. Rinne. 1990.

Pages 94-104 in Krammes, J.S., technical coordinators. Effects of fire management of southwestern natural resources. USDA For. Serv. Gen. Tech. Rep. RM-191.
*Prescribed fire has been used historically as a management tool to create habitat diversity in all upper elevation vegetative types in the region. Research is suggested on the feasibility of using this tool in riparian systems.

Response of birds to wildfire in native versus exotic Arizona grassland.
Bock, C. E. and J. H. Bock. 1992.
Southwest. Nat. 37:73-81.
*We measured vegetation cover and bird abundances on 25 native and 25 exotic grassland plots in southeastern Arizona [USA] between 1984 and 1990. A wildfire in 1987 completely burned 11 native and 11 exotic plots. The fire reduced grass and shrub cover, and increased herb cover, for 2 post-fire years in both grassland types. Numbers of fall birds increased dramatically on burned plots in both habitats for 2 years, probably in response to increased seed production and availability. Species attracted to the burned sites for 2 or 3 years were mourning dove, horned lark, and lark sparrow (Chondestes grammacus). Species avoiding burned lots were grasshopper sparrow (Ammodramus savannarum), Botteri's sparrow (Aimophila botterii), Cassin's sparrow (Aimophila cassinii), and eastern meadowlark (Sturnella magna). Fire effects were ephemeral in both native and exotic habitats for most plants and birds, and there was no evidence that burning facilitated permanent return of native species to depauperate plantations of exotic grasses. However, fire may have rendered exotic grasslands more suitable to certain summer birds by reducing otherwise heavy accumulation of litter.

Exotics

>1980
Ecological effects of planting African lovegrasses in Arizona.
Bock, C. E., J. H. Bock, K. L. Jepson, and J. C. Ortega. 1986.
Natl. Geogr. Res. 2:456-463.
*Summarizes research conducted under a NGS grant.

Riparian systems-water issues

1941-1960
Water development evaluation.
Webb, E. L. 1958.
Proc. 38th Ann. Conf. West. Assoc. State Game and Fish Comms.:251-255.
*Effect on Gambel's Quail populations.

1961-1980
The fatal future. Threatened species doomed.

Manes, R. R. 1968.
Wildlife Views 15(4):4-9.
*Plans of the Corps of Engineers to destroy the habitat along the San Pedro River.

The fatal future. Part IV. The Santa Cruz River.
Schimmel, B. [=R.]. 1968.
Wildlife Views 15(6):24-27.
*Discusses the disaster to wildlife if the streamside vegetation is removed.

Wildlife habitat improvements in relation to watershed management in the southwest.
Reynolds, H.G. 1972.
Arizona Watershed Symposium 16:10-17.

Wildlife conflicts in riparian management: grazing.
Ames, C.R. 1977.
Pages 49-51 in R.R. Johnson, D.A. Jones, technical coordinators. Importance, preservation, and management of riparian habitat: a symposium. USDA Forest Service Gen. Tech. Rep RM-43.
*Reports that grazing has a negative effect on riparian systems; these systems constitute a small but critically important part of the range resource.

The importance of riparian habitat to migrating birds.
Stevens, L.E., B.T. Brown, J.M. Simpson, and R.R. Johnson. 1977.
Pages 156-164 in Johnson, R.R., and D.A. Jones, technical coordinators. Importance, preservation, and management of riparian habitat: a symposium. USDA For. Serv., Gen. Tech. Rep. RM-43.
*Seven pairs of study sites in riparian and adjacent nonriparian habitats were censused for spring migrant passerines to determine the importance of each area.

<u>>1980</u>
Management of riparian vegetation for southwestern wildlife.
Shafer, D.M., P.F. Ffolliott, and D.R. Patton. 1982.
USDA For. Serv., Southwestern Region, Albuquerque, N.M.
*This paper presents a compilation and review of literature on riparian vegetation and its associated wildlife in the southwest. Emphasis is on the natural and man-made factors that limit or alter the effectiveness of riparian communities for wildlife. Five communities are discussed and specific management recommendations are given.

The importance of sycamores to riparian birds in southeastern Arizona.
Bock, C. E. 1984.
J. Field Ornithology 55:97-103.
*Among the mid-elevation riparian trees, sycamores are of potential value to birds because of their large size and substantial dead wood. They also appear to one of the most threatened tree species. Prevention of livestock grazing is not sufficient to regenerate sycamores.

Cowbird parasitism

1900-1920
Red-eyed Cowbird at Sacaton, Arizona.
Gilman, M. F. 1909.
Condor 11:173.
*Just beginning to occur in southeast Arizona, 1909.

1921-1940
Further notes on the birds parasitized by the Red-eyed Cowbird.
Friedmann, H. 1933.
Condor 35:189-191.
*Arizona Hooded Orioles at Tombstone and Oracle, Arizona, are listed as victims.

Further additions to the list of birds victimized by the Cowbird.
Friedmann, H. 1934.
Wilson bull. 46:25-36.
*Adds Tyrannus vociferans, Pyrocephalus rubinus mexicanus, Toxostoma bendirei, Vireo belli arizonae, and Vireo solitarius plumbeus, all from Arizona.

Further additions to the list of birds victimized by the Cowbird.
Friedmann, H. 1934.
Wilson Bull. 46:104-114.
*Includes the Pyrrhuloxia, Rufous-winged Sparrow, and Song Sparrow from Arizona.

Avifauna in Mexico, pp. 69-74, [in] H. K. Buechner and J. H. Buechner, eds. The avifauna of northern Latin America.
Phillips, A. R. 1937.
A symposium held at the Smithsonian Institution 13-15 April 1966. Smiths. Inst. Press. Wash. 119 pp.
*A brief comment (p. 71) that Cowbird parasitism has caused local disappearances of some species in Arizona.

1941-1960
Further additions to the list of birds known to be parasitized by the Cowbirds.
Friedmann, H. 1943.
Auk 60:350-356.
*Vermilion Flycatcher parasitized by the Dwarf Cowbird at Nogales, Arizona.

1961-1980
Host relations of the parasitic Cowbirds.
Friedmann, H. 1963.
U.S. Nat. Mus. Bull. 233:1-276.

*Contains numerous references to Arizona species of birds parasitized by the Cowbirds.

Additional data on the host relations of the parasitic Cowbirds.
Friedmann, H. 1966.
Smiths. Misc. Coll. 149:1-12.
*Contains several records from Arizona.

Changing status of the Bronzed Cowbird in Arizona.
Johnson, R. R. and B. Roer. 1968.
Condor 70:183.
*Extending breeding and wintering ranges north of Tucson, and increasing in numbers throughout core of range.

>1980
A record of brown-headed cowbird (Molothrus ater) nest parasitism of rufous-crowned sparrows (Aimophila ruficeps).
Miles, D. B. 1986.
Southwest. Nat. 31:253-254.

Thick-billed parrot

1900-1920
Parrots in the United States.
Lusk, R. D. 1900.
Condor 2:129.
*Rhynchopsitta pachyrhyncha observed in the Chiricahua Mountains.

The Thick-billed Parrot in Arizona.
Smith, A. P. 1907.
Condor 9:104.
*Observed in the Chiricahua Mountains.

Report of Thick-billed Parrots in Arizona.
Law, J. E. 1918.
Condor 20:100.

1921-1940
Arizona records of the Thick-billed Parrot.
Vorhies, C. T. 1934.
Condor 36:180-181.
*In the Chiricahua Mountains.

1960-1980
A pessimistic view-the Thick-billed Parrot.
Monson, G. 1965.
Aud. Field Notes 19:389.
*Brief mention of Arizona occurrences.

≥1980
Thick-billed parrots. Homecoming for a native us parrot.
Clubb, S.L. 1991.
Psitta Scene 3: 7-9.

A return to the thick-billed parrot.
Johnson, T., and N. Snyder. 1987.
Wildl. Views 30:8-10.

Thick-billed parrot reintroduction project progress report of 12-23-91.
Johnson, T. B., N. F. R. Snyder, and M. A. Franks. 1992.
Am. fed. Avic. Watchbird 19:53-54.

Reintroduction of the thick-billed parrot in Arizona.
Snyder, N. F. R. and M. P. Wallace. 1987.
Pages 360-384 in Anon. (ed.), Proc. Jean Delacour/IFCB Symposium on breeding birds in captivity. [Publisher & place of publication not given.]

Reintroduction of thick-billed parrot Rhynchopsitta pachyrhyncha in Arizona.
Snyder, N. F. R. and T. V. Johnson. 1988.
Dodo no. 25:15-24.

Reintroduction of the thick-billed parrot in the Chiricahua Mountains.
Snyder, N.F.R., and T.B. Johnson. 1992.
Pages 87-90 in Chiricahua Mountains Research Symposium Proceedings. Southwest Parks and Monuments Association, Tucson, Arizona.
*History of reintroduction attempts of the thick-billed parrot.

Welcome back!! The thick billed parrot returns to Arizona.
Tashijan Hanson, J., and N. Synder. 1987.
West. Tanager 53:1-3.

Gallinaceous birds

1800s
The Masked Bob-white (Colinus ridgwayi) of Arizona and its allies.

Allen, J. A. 1886.
Bull. Amer. Mus. Nat. Hist. 1(7), art. 16:273-290.
*Contains history, bibliography, habits, and distribution.

1900-1920
Masked Bob-white (Colinus ridgwayi).
Brown, H. 1904.
Auk 21:209-213.
*History, distribution, and observations on habits; believes it to be extinct in Arizona.

1921-1940
What makes Turkeys wild?
[Weekes, R. W., ed.] 1927.
Ariz. Wild Life 1(4-5):9.
*Turkeys released in the Chiricahuas became tame.

Do southwestern Quail require water?
Vorhies, C. T. 1928.
Amer. Nat. 62:446-452.
*Evidently they do not.

Masked Bob White released in forest.
[Anonymous.-ed]. 1938.
Ariz. Wildlife Mag. 7(8):16.
*In Coronado National Forest grass area, 66 released.

1941-1960
Mearns' Quail numerous in Arizona.
Scheffler, W. J. 1941.
Condor 43:208.

Investigational report and proposed Quail management plan for Cochise County, Arizona.
Griner, L., et al.194-?
(An activity of Ariz. Fe. Aid Proj. 9-R) Ariz. Game and Fish comm. 19 pp.

The vanishing Masked Bobwhite.
Ligon J. S. 1952.
Condor 54:48-50.
*Brief notes on the attempt to introduce the species in Arizona.

A preliminary evaluation of Quail malaria in southern Arizona in relation to habitat and Quail mortality.
Hungerford, C. R. 1955.

Trans. 20th N. A. Wildlife Conf. March 14, 15, and 16, 1955:209-215.

The effects of hunting on Gambel Quail populations.
Swank, W. G. and S. Gallizioli. 1958.
Trans. 23rd N. A. Wildl. Conf. March 3, 4, 5, 1958:305-319.

Report of endangered species of wildlife committee.
Towell, W. E. 1958.
[In] 48th Conv. Int. Assoc. Game, Fish and Conservation Comms.: 35-44.
*Mearns' Quail, p. 36: habitat improvement required in Arizona.

1961-1980

Population figures of Arizona's Mearns' Quail.
Bishop, R. [A.]. 1964.
Proc. 3rd Ann. Meeting Wildl. Soc. New Mex.-Ariz. Sec. Feb. 7, 8, 1964:58-61.
*In the Santa rita Mountains and Canelo Hills.

Results of a brief investigation of the Masked Bobwhite in Sonora, Mexico.
Gallizioli, S. 1964.
Ariz. Game and Fish Dept. Spec. Rep. 15 pp.
*Includes a summary of efforts to restock this bird in Arizona.

Return of the Masked Bobwhite.
Walker, L. W. 1964.
Ariz.-Son. Desert Museum, Spec. Bull. 7 pp.
*Describes an attempt to reestablish the species in Arizona.

Return of the Masked Bobwhite.
Walker, L. W. 1964.
Zoonooz 37(1):10-15.
*A summary of the preliminary attempt to establish this species in the vicinity of Tucson, Arizona.

Use of tape recorded female Quail calls during the breeding season.
Levy, S. H., J. J. Levy, and R. A. Bishop. 1966.
Jour. Wildl. Mgmt. 30:426-428.
*In southeastern Arizona, male Harlequin, Gambel's and Scaled Quail responded to the recorded calls.

Mearns' Quail, Arizona's finest upland game bird.
Gallizioli, S. 1967.
Wildlife Views 14(6):4-7.

Can the Masked Bobwhite be saved from extinction?

Gallizioli, S., S. Levy, and J. Levy. 1967.
Aud. Field Notes 21:571-575.
*They are hopeful that it can be reestablished in Arizona.

Our Bobwhites come home.
Tomlinson, R. E. and D. E. Brown. 1970.
Wildlife Views 17(3):4-11.
*Report on recent introductions in Arizona.

A research program for the endangered masked bobwhite.
Ellis, D. H. and J. A. Serafin. 1976.
J. Wild Pheasant Assoc. 2:16-33.

Habitat use by native Gambel's and scaled quail and released masked bobwhite quail in southern Arizona.
Goodwin, J. G., Jr. and C. R. Hungerford. 1977.
USDA For. Serv. Res. Rep. No. RM-197.
*A program to reintroduce the masked bobwhite quail (Colinus virginianus ridgwayi) to its original mesquite (Prosopis juliflora)/grassland habitat is reported. Conditions have changed since the bird disappeared from the area in 1900, and it is in possible competition with Gambel's quail (Lophortyx gambelii) and scaled quail (Callipepla squamata). Preferred habitats of the 3 species and their use of open water are described; there was some overlap between Gambel and bobwhite habitats. Frequency of the most common causes of mortality was also investigated (predators, weather. etc.). Management recommendations for improving bobwhite habitat are outlined and include irrigation and control of grazing by livestock. 8 ref.

Reintroduction techniques for masked bobwhites. 345-354, illustr.
Ellis, D. H., S. J. Dobrott, and J. G. Goodwin Jr. 1978.
Pages 345-354 in Temple, S. A. (ed.), Endangered birds. Management techniques for preserving threatened species. Univ. Wisconsin Press.

Masked bobwhite recovery plan approved.
Finnley, D. (ed.). 1978.
Endangered Species Tech. Bull. 3:3.

>1980
Potential role of the Research Ranch in the masked bobwhite recovery program.
Stromberg, M. R., C. E. Bock, and J. H. Bock. 1986.
In M.R. Stromberg, T. Johnson, S. Hoffman, eds., Proceedings of a symposium on the biology and conservation of the masked bobwhite. Arizona Game and Fish Dept., Phoenix, Arizona, and National Audubon Society.
*Only a small area of the Audubon Research Ranch (near Elgin) might be suitable for the masked bobwhite. If a release does occur, it must be clearly stated as experimental and secondary to the

primary release site.

Status, distribution, and habitat use of Gould's turkey in the Peloncillo Mountains, New Mexico.
Willging, R.C. 1987.
Ph.D. diss., New Mexico State Univ., Las Cruces.

Distinguishing individual male wild turkeys by analyzing vocalizations using a personal computer.
Dahlquist, F. C., S. D. Schemnitz, and B. K. Flachs. 1990.
Bioacoustics 2:303-316.
*The system has proven to be a valuable tool in determining census data and movement information on the male Gould's wild turkey in SW New Mexico. Plans for future use are for the differentiation of subspecies, identification of individual females and the analysis of specific turkey cells.

Captive breeding and reintroduction of the endangered masked bobwhite.
Carpenter, J. W., R. R. Gabel, and J. F. Goodwin, Jr. 1991.
Zoo Biol. 10:439-449.

Ecology and management of Gould's turkeys in southwestern New Mexico.
Schemnitz, S. D., D. E. Figert, and R. C. Willging. 1991.
Pages 72-83 in Healy, W. M. and G. B. Healy (eds.), Proc. Nat. wild turkey symposium, 6.
National Wild Turkey Federation, Edgefield, S. Carolina.

Doves and Pigeons

1921-1940
Range, population, and game status of the Western White-winged Dove in Arizona.
Neff, J. A. 1940.
J. Wildl. Mgmt. 4:117-127.

1941-1960
Conservation notes.
Allen, F. H. 1941.
Auk 58:288.
*Comments on the "critical" situation of the White-winged Dove in Arizona.

Help for the White-winged Dove.
Baker, J. H. 1941.
Aud. Mag. 43:68,71.
*Remarks on its scarcity in Arizona.

1961-1980

Annual report of the Migratory Birds Committee.
Evans, T. R. 1966.
[In] 56th Conv. Int. Assoc. Game, Fish and Conservation Comms. 34-43pp.
*White-winged Dove, p. 39: breeding population estimated at 1,250,000 in Arizona.

Return of the Bandtails.
Schimmel, B. [=R.]. 1967.
Wildlife Views 14(5):22-26.
*Brief notes on banding, with map of range in Arizona.

Raptors

1921-1940
Notes on rare and little known neotropical Pygmy Owls.
Griscom, L. 1931.
Proc. New England Zool. Club 12:37-43.
*Includes comments on Glaucidium gnoma in Arizona.

1961-1980
Bad days for the Black Hawk.
Hubbard, J. P. 1965.
Aud. Field Notes 19:474.
*Comments on the destruction of its cottonwood bosque habitat.

The Gray Hawk in the southwest.
Zimmerman, D. A. 1965.
Aud. Field Notes 19:475-477.
*Comments on habitat destruction.

The status of the gray hawk in New Mexico.
Hubbard, J. P. 1974.
Auk 91:163-166.

The gray hawk in Arizona: its population, habitat, breeding ecology, and status.
Glinski, R. L. 1977.
J. Ariz. Acad. Sci. 12:30.

Chemical residues in Arizona Harris hawk eggs.
Mader, W. J. 1977.
Auk 94:587-588.
*Eggshell thinning did not occur, and chemical residues were minor.

Black hawks and mining on Eagle Creek, Arizona.
Snyder, H. and R. L. Glinski. 1978.
Arizona-Nevada Academy of Science 13:29.
*Black hawks (Buteogallus anthracinus) occur along select riverine habitats in Arizona and New Mexico, and are dependent on permanent surface water for successful breeding. Eagle Creek presently sustains a dense nesting population of this rare raptor because the waterflow in much of this drainage is supplemented by the mining activity of the Phelps-Dodge Copper Company in Morenci, Arizona. Water for mining is pumped from the black River watershed into a tributary of Eagle Creek and allowed to flow naturally down Eagle Creek to near Morenci, where it then is piped uphill to the mining plant.

>1980
The effect of mining and blasting on breeding prairie falcon (Falco mexicanus) occupancy in the Caballo Mountains, New Mexico.
Bednarz, J. C. 1984.
Raptor Res. 18:16-19.

The decline of the aplomadao falcon in the United States.
Hector, D. P. 1987.
Am. Birds 41:381-384.

Peregrine falcons are now less in peril.
Kimsey, B. 1992.
N. M. Wildl. 37:22-24.

The effects of human activities on the productivity of birds of prey in the Los Medanos area, New Mexico.
Bednarz, J. C. and T. J. Hayden. 1994.
Raptor Research 28:52-53.

Other topics

1900-1920
Are the habits of birds changing?
Breninger, G. F. 1905.
Auk 22:360-363.
*Unusual nesting sites of several species in southern Arizona.

1921-1940
The White-necked Raven, a change of status?
Vorhies, C. T. 1934.
Condor 36:118-119.

*The Ravens disappeared when the garbage dumps were removed.

Are small birds decreasing?
Brooks, A. 1935.
Bird-Lore 37:199-200.
*Includes Arizona.

A blot on G. P. A. activities.
Vorhiew, C. T. 1935.
Ariz. Wild Life 6(9):1.
*Condemns a campaign offering bounties on Hawks, Crows, and Roadrunners.

1941-1960
Southwestern game management problems.
Kimball, T. L. 1949.
Proc. 29th Ann. Conf. West. Assoc. State Game and Fish Comms. June 14, 15, 16, 1949:57-60.

Vegetation change and arroyo cutting in southeastern Arizona.
Hastings, J. R. 1959.
Jour. Ariz. Acad. Sci. 1:60-67.
*An important paper on early conditions that affected animal life.

1961-1980
What has happened to the Mexican Duck?
Levy, S. H. 1964.
Aud. Field Notes 18:558-559.
*Its habitat in the San Simon Cienega is threatened.

Quack comeback.
Kerr, R. M. 1966.
Our Public Lands 16(2):4-5.
*The population of the New Mexican Duck is estimated to be about 20 in Arizona.

Will you see any game today?
Martin, S. C. 1966.
Prog. Agric. Ariz. 18(4):30-31.
*Brief account of surveys on the Santa Rita Experimental Range, Arizona.

A federal research program for endangered wildlife.
Erickson, R. C. 1968.
[In] Trans. 33rd N. Amer. Wildl. and Nat. Resources Conf. March 11-13, 1968:418-433.

The fatal future. Part V. Statewide summary.

Bristow, B. 1969.
Wildlife Views 16(5):13-21.
*The clearing of phreatophytes endangers Arizona wildlife.

Factors influencing breeding range expansion of the Azure Bluebird.
Ligon, J. D. 1969.
Wilson Bull. 81:104-105.
*Scarcity of nest sites important.

The status of Cassin's sparrow in New Mexico and adjacent states.
Hubbard, J. P. 1977.
Am. Birds 31:933-941.

Eared trogon immigrant or visitor the story of the appearance of Euptilotis-neoxenus in the mountains of southern Arizona USA.
Zimmerman, D. A. 1978.
Am. Birds 32:135-139

>1980
Responses of selected wildlife species to the removal of mesquite from desert grassland.
Germano, D.J., R. Hungerford, and S. C. Martin. 1983.
J. Range Manage. 36:309-311.
*Activities of selected wildlife species were observed from September 1976 to June 1978 in an undisturbed velvet mesquite (Prosopis juliflora var. velutina) stand, on range cleared of mesquite, and in a mesquite stand with spot clearings on the Santa Rita Experimental Range near Tucson, Ariz. More black-tailed jack-rabbits (Lepus californicus), antelope jackrabbits (Lepus alleni), and Gambel's quail (Lophortyx gambelii), were seen in undisturbed mesquite and mesquite with clearings than on mesquite-free range. Likewise, more bird calls were heard in the undisturbed and partially cleared mesquite than on mesquite-free range. Apparent differences in bird and mammal populations between the undisturbed stand and the partially cleared stand were not significant and were generally small.

Nest boxes as a coppery-tailed trogon management tool.
Hakes, W. A. 1983.
USDA Gen. Tech. Rep 99-RM:147-150.

Power pole damage to acorn woodpeckers in southeastern Arizona.
O'Brien, G. P. 1983.
USDA For. Serv. Gen. Tech. Rep. RM-99:14-18.

Once a river: bird life and habitat changes on the middle Gila.
Rea, A. M. 1983.
Univ. Arizona Press, Tucson.

*Discusses the history of the Gila River, concentrating on negative impacts caused by lowering of the water table and associated riparian vegetation.

Wildlife in southeastern Arizona between 1859 and 1890.
Bahre, C.J. 1985.
Desert Plants 7:190-194.
*Discusses the status of wildlife during the indicated period.

Value of suburban habitats to desert riparian birds.
Rosenberg, K. V., S. B. Terrill, and G. H. Rosenberg. 1987.
Wilson Bull. 99:642-654. [Note: not conducted in study region but an appropriate paper]
*Bird populations were monitored over 20 consecutive months in suburban Tempe, Arizona. Compared to native riparian habitats (cottonwood-willow and mesquite), the suburban plots appeared to support significantly higher total bird densities in every month. Ten native species occurred in significantly higher density on the suburban transects than in outlying riparian habitats in at least one season. Overall, 53% of the riparian breeding species, and 85% of the winter residents also occurred in suburban Tempe. Absence of other riparian species from the suburban sites may be attributed either to interference by abundant, urban-adapted species or an inability to exploit nonnative tree species. Other suburban sites containing native willows and cottonwoods support populations of several obligate riparian species not found in Tempe. We suggest that well-vegetated suburban habitats have much potential in mitigating against the rapid loss of native riparian vegetation in the Southwest.

Wildlife management.
Deecken, T. 1988.
Pages 77-78 in P.F. Ffolliott, and J.D. Hasbrouck, eds. Oak woodland management: proceedings of the workshop. School of Renewable Natural Resources, Univ. Arizona.
*Wildlife management practices of the USDA Forest Service in the oak woodlands of southeastern Arizona are discussed.

Competition between European starlings and native woodpeckers for nest cavities in saguaros.
Kerpez, T. A. and N. S. Smith. 1990.
Auk 107:367-375.
*European starlings (Sturnus vulgaris) have recently invaded Arizona and breed in some areas but not in similar areas nearby. In Arizona, European Starlings commonly nest in cavities in saguaro cacti (Carnegiea gigantea) but do not excavate these cavities. We found that European Starlings compete with Gila Woodpeckers but not with Northern Flickers. This competition decreases the number of Gila Woodpeckers that nest in areas where European Starlings nest. Starlings did not use Northern Flicker nest cavities, and we found no relationship between the number of European Startling nests and the number of Northern Flicker nests.

Experimental dispersal of wintering snow and Ross' geese.
Taylor, J. P. and R. E. Kirby. 1990.

Wildl. Soc. Bull. 18:312-319.

Should we terminate an "artificial," tree-nesting raptor population in Arizona.
Ellis, D. H., D. G. Smith, and F. B. P. Trahan. 1994.
Journal of Raptor Research 28:56.

Daniel, A., J. Holechek, R. Valdez, A. Tembo, L. Saiwana, M. Fusco, and M. Cardenas. 1993. Jackrabbit densities on fair and good condition Chihuahuan desert range. J. Range Manage. 46:524-528.

Abstract: This study was conducted on Chihuahuan desert range near Las Cruces, in southcentral New Mexico, to determine the relationship of blacktailed jackrabbit (Lepus californicus) densities to good (GC) and fair (FC) range condition. The Soil Conservation Service procedure was used to classify ecological range condition. Line transect procedures were used to estimate jackrabbit populations from July 1988 to December 1990. Concurrently vegetation cover and mean plant height were determined with the line intercept procedure. Jackrabbit densities on the fair condition range were higher ($P<0.10$) than those on the good condition range. This difference is attributed to the fair condition range containing more protective cover and preferred forage than good condition range. Jackrabbit abundance showed no season ($P<0.10$) or year differences ($P<0.10$). Jackrabbits preferred grass-shrub mosaic habitats more than shrubland and grassland habitats. The need for diverse food sources and protective cover were apparently major determinants of habitat selection by jackrabbits. The good condition range contained greater ($P<0.10$) grass cover and less ($P<0.10$) shrub cover than the fair condition range. Our results indicated that maintaining Chihuahuan desert ranges in good to excellent condition is the best means of achieving lower abundance of jackrabbit populations.

Fatehi, M., R. D. Pieper, and R. F. Beck. 1988. Seasonal food habits of blacktailed jackrabbits (Lepus californicus) in southern New Mexico. Southwestern Nat. 33:367-370.

Steinberger, Y., and W. G. Whitford. 1983. The contribution of shrub pruning by jackrabbits to litter input in a Chihuahuan desert ecosystem. J. Arid Environ. 6:183-187.

Abstract: Jackrabbits, Lepus californicus, prune stems from creosote-bushes Larrea tridentata during the dry winter months, eating the previous season new woody stems allowing the leaves and old wood to fall to the ground. This unconsumed material was 66 kg/ha/year of stem and 35 kg/ha/year of leaves; approximately one-fifth of the quantity of shrub litter input by natural infall. Jackrabbits preferentially pruned stems of shrubs with higher tissue moisture content. Rabbits tend to prune stems from the same shrubs in successive years.

Bock, C. E., and J. H. Bock. 1978. Response of birds, small mammals, and vegetation to burning sacaton grasslands in southeastern Arizona. J. Range Manage. 31:296-300.

Abstract: We studied the impact of fire on an ungrazed sacaton grassland community at The Research Ranch in southeastern Arizona. Two summer burns were followed through two post-fire growing seasons. A winter burn was studied through one post-fire growing season. Burning reduced the height and extent of sacaton grass (Sporobolus wrightii) itself, and stimulated growth of other grasses and forbs. Summer fires created more bare ground and encouraged a greater number and variety of annuals than the winter fire. The fires had the effect of reducing total small-mammal populations and greatly increasing bird populations. These results were more dramatic on the areas which burned in early summer than on the winter-burned plot. Raptors and most game birds, particularly mourning doves, were most abundant on one-year-old burns. Seed-eating birds (Fringillidae) preferred burned over unburned areas. Cotton rat (Sigmodon hispidus) populations were greatly reduced by the fires, while populations of seed-eating pocket mice (Perognathus) and kangaroo rats (Dipodomys) increased, especially on the summer burns. Sacaton grasslands recover rapidly even from summer burning, at least in the absence of livestock. Results of this study suggest that fire is beneficial to the indigenous plants and wildlife of sacaton communities, as long as a mosaic of different aged stands is maintained.

Bock, C. E., J. H. Bock, W. R. Kenney, and V. M. Hawthorne. 1984. Responses of birds, rodents, and vegetation to livestock exclosure in a semidesert grassland site. J. Range Manage. 37:239-242.

Abstract: Livestock have been excluded from a 3,160-ha range in southeastern Arizona since 1968. Compared to an adjacent continuously grazed area, in 1981-82 a protected upland site supported 45% more grass cover, a comparatively heterogeneous grass community, and 4 times as many shrubs. Grama grasses (Bouteloua spp.) were equally common in and outside the exclosure, while a variety of other species, especially plains lovegrass (Eragrostis intermedia) and Arizona cottontop (Trichachne californicum) were much more abundant on the protected site. The grazed area supported significantly higher numbers of birds in summer, while densities did not differ in winter. Rodents were significantly more abundant inside the protected area. Species of birds and rodents more common in the grazed area included those typical of more xeric lowland habitats and those preferring open ground for feeding. Species more common on the protected site were those which characterize semidesert or plains grasslands, and which prefer substantial grass or shrub cover. Grazing appeared to favor birds as a class over rodents.

Bowers, M. A., D. B. Thompson, and J. H. Brown. 1987. Spatial organization of a desert rodent community: food addition and species removal. Oecologia (Berlin) 72:77-82.

Abstract: From 1977 through 1983 we conducted experiments on a desert rodent community

where supplemental seeds were added or certain rodent species and ants were removed from 0.25-ha fenced plots in a Chihuahuan Desert site in southeastern Arizona, USA. In this paper we examine the patterns of microhabitat use relative to vegetative cover by 11 rodent species. The results show that: i) removal of the largest seed-eating species, Diplodomys spectabilis, produced the most pervasive and dramatic shifts in micro-habitat use by the remaining rodent species; ii) adding seeds or removing ants had little effect on the spatial use of micro-habitats by rodents in this community; and iii) non-granivores were just as likely as granivores to shift microhabitat use when other granivores were removed. We believe these results indicate that both food and foraging microsites are limited but the relegation of subdominant species to less-preferred microhabitats by the large Dipodomys spectabilis is the major factor underlying the spatial organization of this community. Results also demonstrate that strong interactions among species increase the probability that pathways of indirect interactions through intermediary species are important; these complex linkages may include species that overlap little in food preferences.

Brown, J. H., and D. W. Davidson. 1986. Reply to Galindo. Ecology 67:1423-1425.

Brown, J. H., and E. J. Heske. 1990. Temporal changes in a Chihuahuan Desert rodent community. Oikos 59:290-302.

Abstract: We used time series analysis of ten years of monthly census data to assess the

responses of both individual species and an entire community of rodents to a fluctuating desert environment. Autocorrelation analysis revealed different patterns of intra-annual fluctuation among the 11 species: Dipodomys spectabilis and Perognathus flavus had pronounced annual cycles; D. ordii, D. merriami, Chaetodipus penicillatus, Onychomys torridus, O. leucogaster, and Neotoma albigula exhibited annual cycles modified by interannual variation; and Peromyscus eremicus, P. maniculatus, and Reithrodontomys megalotis showed little evidence of annual periodicity. The timing of annual and the pattern of inter-annual fluctuations also differed among species. However, two results suggest that several species responded similarly to long-term environmental variation: 1) population densities of four species and total rodent biomass and numbers were positively correlated with the densities of annual plants; and 2) many pairs of species exhibited positively correlated population dynamics over the ten years.

Brown, J. H., and J. C. Munger. 1985. Experimental manipulation of a desert rodent community: food addition and species removal. Ecology 66:1545-1563.

Abstract: Since 1977 we have been conducting experiments in which we add supplemental seeds or remove certain combinations of species of seed-eating rodents and ants from 0.25-ha plots in the Chihuahuan Desert of southeastern Arizona. These experiments evaluate the extent to which food availability and interspecific competition influence rodent populations. Monitoring with live traps revealed that: (1) the addition of seed at the rate of 96 $kg \cdot plot^{-1} \cdot yr^{-1}$ resulted in an increased density of the largest granivorous rodent species (Dipodomys spectabilis), decreases in the densities

of the two next-to-largest species (D. merriami and D. ordii), and no detectable changes in the densities of other rodents; (2) the removal of D. spectabilis, as well as other experimentally induced changes in the abundance of this species, resulted in reciprocal shifts in the densities of the two congeneric species, D. merriami and D. ordii, and no significant changes in densities of other rodents; and (3) the removal of all three Dipodomys species resulted in large increases in density of four of the five species of smaller seed-eating rodents, but had no effect on two species of insectivorous rodents. Taken together, these results indicate that limited food resources and interspecific competition play major roles in regulating the density of rodent populations and determining the organization of desert rodent communities. However, the responses of the rodent populations to our manipulations were unexpectedly complex; they included long time lags, asymmetrical interactions, and little compensation in energy consumption. This indicates how much remains to be learned about the processes that determine the structure and function of even this relatively simple and well-studied community.

Brown, J. H., and Z. Zeng. 1989. Comparative population ecology of eleven species of rodents in the Chihuahuan Desert. Ecology 70:1507-1525.

Abstract: Comparisons of mark-recapture data on life histories and population dynamics of the 11 commonest species of nocturnal desert rodents inhabiting our experimental study site in the Chihuahuan Desert of extreme southeastern Arizona permitted assessment of the role of evolutionary relationships and ecological factors in the coexistence of these species. The species varied greatly in

population density, extent of interannual variation in abundance, timing of reproduction, extent to which reproduction was seasonal, rate of disappearance of marked individuals, frequency and distance of lifetime dispersal movements, but perhaps less so in death rate and maximum longevity. Most of the species showed positively correlated year-to-year fluctuations in population density, suggesting that they responded similarly to interannual variation in precipitation, primary production, and availability of food resources. In contrast, there were both positive and negative correlations in seasonal patterns of reproductive activity and population density. Lifetime dispersal movements were inversely related to body size, suggesting that energy constraints cause the smallest species to move among rich patches in a coarse-grained manner. Patterns of similarities and differences among closely related (congeneric and confamilial) species suggested that evolutionary constraints sometimes, but not always, limited variation in life history and demography. The relationship between population ecology and competition among these species was not clear.

We interpret the diversity of life histories and population dynamics in these coexisting species to be a consequence of: (a) a productive and spatially and temporally variable environment that provides a variety of resources that may be used in different ways, (b) historical biogeographic events that have made available a large regional pool of species from which potential colonists can be drawn, and (c) differences in population ecologies among the species that evolved primarily in other environmental contexts, but that permit coexistence by enabling the species to use different resources or to use the same resources in different ways.

Brown, J. S. 1989. Desert rodent community structure: a test of four mechanisms of coexistence. Ecol. Monogr. 59:1-20.

Abstract: Four mechanisms of coexistence are considered that may contribute to the diversity of desert granivorous rodent communities. In the first, bush/open microhabitat selection, coexistence is possible if there is a trade-off between foraging efficiency in the bush and open microhabitats. In the second, temporal variation in resource abundances, coexistence is possible if there is a trade-off between foraging efficiency and maintenance efficiency. The first species can forage profitably on low resource abundances while the second uses dormancy to travel inexpensively in time between periods of high resource abundances. In the third, spatial variation in resource abundance, coexistence is possible if there is a trade-off between foraging efficiency and the cost of travel. The first species forages patches to a lower giving-up density, (the density of resource at which a forager ceases foraging), while the second can inexpensively travel between patches with high resource abundances. In the fourth, seasonal rotation in foraging efficiencies, coexistence is possible if there is a trade-off between the costs of foraging during different seasons. The species that is the more efficient forager changes seasonally.

Brown, J. S. 1989. Mechanisms underlying the organization of a desert rodent community. J. Arid Environ. 17:211-218.

Davidson, D. W., R. S. Inouye, and J. H. Brown. 1984. Granivory in a desert ecosystem: experimental evidence for indirect facilitation of ants by rodents. Ecology 65:1780-1786.

Abstract: Two major groups of desert granivores, ants and rodents, coexist as permanent residents of local desert habitats in southwestern North America. At our Sonoran Desert study site, both of the major taxa exhibited short-term increase in density when the other taxon was experimentally removed. Over the longer term, density compensation continued at a relatively constant level for rodents in the absence of ants. In contrast, beginning about 2 years after initiation of experiments, ant populations on rodent removal plots showed a gradual but significant decline relative to densities on control plots.

Indirect interactions, mediated through ant and rodent resources, may account for these differences. Removal of harvester ants leads to higher annual plant densities only in small-seeded species. These plants are relatively poor competitors and do not displace the large-seeded annuals, on whose seeds rodents specialize. In contrast, rodent removal leads to a differential increase in large-seeded annuals, which competitively displace the small-seeded resource species of ants. The decline of ant populations on rodent removal plots preceded by several years the first detectable evidence for competitive suppression of small-seeded annuals. Because ants do not excavate buried seed, they probably experienced resource depression before buried see reserves were exhausted through germination and subsequent competitive inhibition.

Davidson, D. W., D. A. Samson, and R. S. Inouye. 1985. Granivory in the Chihuahuan Desert: interactions within and between trophic levels. Ecology 66:486-502.

Abstract: We investigated the effects of Chihuahuan Desert granivores on three seasonal classes of plant resource species, the effects of these resources classes on one another, and the ways in which interactions through plant resources affect the abundances of seed consumers. In general, our experiments show that, despite the climatic variability and unpredictability of desert environments, populations respond to the steady deterministic processes of competition and predation. Nevertheless, comparison of the results of similar experimental studies in the Sonoran and Chihuahuan Deserts demonstrates how climate and seasonality can alter the structure and intensity of interactions in ecosystems.

Frank, D. H., and E. J. Heske. 1992. Seasonal changes in space use patterns in the southern grasshopper mouse, Onychomys torridus torridus. J. Mammal. 73:292-298.

Abstract: Radiotelemetry studies of Onychomys torridus torridus in the Chihuahuan Desert revealed that the home ranges of breeding males were twice as large as those of breeding females. Further, home ranges of females overlapped only slightly, whereas home ranges of males overlapped extensively with those of both females and other males. Radiotelemetry data collected at the same site during the nonbreeding season showed that: home ranges of nonbreeding adult males were significantly smaller than those of breeding males; home ranges of nonbreeding adult females did not

differ in size from those of breeding females; home ranges of nonbreeding males and females did not differ significantly in size. Home-range overlap among neighboring females also was greater during the nonbreeding season, and many individuals of both sexes shared day burrows at this time. In total, these patterns support hypotheses that males compete among themselves for reproductive females.

Galindo, C. 1986. Do desert rodent populations increase when ants are removed? Ecology 67:1422-1423.

Heske, E. J., J. H. Brown, and S. Mistry. 1994. Long-term experimental study of a Chihuahuan Desert rodent community: 13 years of competition. Ecology 75(2):438-445.

Abstract: An experimental study of competition between kangaroo rats (Dipodomys spp.) and other sympatric desert rodents using exclosures with "semipermeable" fences has been continuously maintained at a site in the northern Chihuahuan Desert since 1977. A new set of experimental manipulations begun in 1988 at the same site repeated this study. The continuous presence of competition between small granivores and kangaroo rats over the 13-yr study despite large, species-specific fluctuations in abundances suggests that competition is pervasive within this community.

Heske, E. J., J. H. Brown, and Q. Guo. 1993. Effects of kangaroo rat exclusion on vegetation structure and plant species diversity in the Chihuahuan Desert. Oecologia 95:520-524.

Abstract: Long-term (1977-90) experimental exclusion of three species of kangaroo rats from study plots in the Chihuahuan Desert resulted in significant increases in abundance of a tall annual grass (Aristida adscensionis) and a perennial bunch grass (Eragrostis lehmanniana). This change in the vegetative cover affected use of these plots by several other rodent species and by foraging birds. The mechanism producing this change probably involves a combination of decreased soil disturbance and reduced predation on large-sized seeds when kangaroo rats are absent. Species diversity of summer annual dicots was greater on plots where kangaroo rats were present, as predicted by keystone predator models. However, it is not clear whether this was caused directly by activities of the kangaroo rats or indirectly as a consequence of the increase in grass cover. No experimental effect on species diversity of winter annual dicots was detected. Our study site was located in a natural transition between desert scrub and grassland, where abiotic conditions and the effects of organisms may be particularly influential in determining the structure and composition of vegetation. Under these conditions kangaroo rats have a dramatic effect on plant cover and species composition.

Heske, E. J., and M. Campbell. 1991. Effects of an 11-year livestock exclosure on rodent and ant numbers in the Chihuahuan Desert, southeastern Arizona. Southwestern Nat. 36:89-93.

Abstract: We censused rodents, counted ant colonies, and measured vegetative structure

along 11 pairs of transects at a Chihuahuan Desert study site in southeastern Arizona. One member of each pair of transects was inside and one was outside of a 20-ha livestock exclosure that had been in place for 11 years. Vegetative structure did not differ between transects exposed to or protected from cattle grazing, but significantly more rodents were captured inside and outside of the exclosure, indicating that ants are more resistant than rodents to trampling and potential competition for food with cattle.

Inouye, R. S. 1981. Interactions among unrelated species: granivorous rodents, a parasitic fungus, and a shared prey species. Oecologia 49:425-427.

Abstract: Granivorous rodents and a parasitic fungus in the Sonoran Desert utilize a common prey species, Erodium cicutarium, a desert annual plant. Experimental removal of rodents from field exclosures resulted in significantly higher densities of E. cicutarium. Fungal infection was significantly higher in the absence of rodents, suggesting that, while they do not interact directly, rodents and the fungus affect each other's densities by their use of a common prey species.

MacKay, W. P., and S. A. Elias. 1992. Late quaternary ant fossils from packrat middens (Hymenoptera: Formicidae): implications for climatic change in the Chihuahuan Desert. Psyche 99:169-184.

Abstract: Packrat (Neotoma spp.) middens in rock-shelters provide important paleoecological

records for the desert regions of North America. Specimens of various arthropod species accumulate in the middens and are cemented into a black, tarry mass by packrat urine.

We collected a variety of ants, including the genera Labidus, Pseudomyrmex, Aphaenogaster, Crematogaster, Pheidole, Pogonomyrmex, Solenopsis, Trachymyrmex, Liometopum, and Camponotus in packrat middens from the Chihuahuan Desert. Our data suggest a climatic change in the Chihuahuan Desert from mesic to arid during the past 45,000 years. The coniferous forest, oak-juniper woodland of the early Holocene changed to desert-grassland about 8250 radiocarbon years before present (yr BP), with a corresponding shift in ant species composition. By about 7500 yr BP, the presence of several arid adapted species suggests the establishment of desert environments. Finally after about 2500 yr BP, we see the occurrence of primarily desert adapted ant species in the Chihuahuan Desert, although mesic adapted species continue to occur in moist "islands" within the area. The paleoenvironmental data derived from the ant fossil records agrees closely with previous reconstructions based on other arthropods.

McAuliffe, J. R. 1990. Paloverdes, pocket mice, and bruchid beetles: interrelationships of seeds, dispersers, and seed predators. Southwestern Nat. 35:329-337.

Abstract: Seed dispersers and seed predators present a diverse array of benefits and risks to Cercidium microphyllum, a leguminous tree of the Sonoran Desert. Fruits mature and fall to the ground before the onset of summer rains. Seeds on the ground are rapidly collected by heteromyid rodents, but many are not consumed; these seeds may later germinate from buried caches.

Approximately half of all newly emerged seedlings are in tight clusters that indicate an origin from caches. Not all seeds in a cache germinate simultaneously. Viable, ungerminated seeds associated with newly emerged seedlings face additional risks of discovery by heteromyids. because of olfactory cues associated with emerging seedlings. Whereas heteromyids function to some degree as dispersers, bruchid beetles function only as seed predators. The hypothesis that heteromyids may hide seeds from bruchids by removing them from areas beneath parent trees was tested experimentally. Seeds retained in the tree canopy suffered almost complete destruction by bruchids. However, contrary to expectations, bruchids avoided ovipositing on seeds caged on the ground beneath parent trees. This avoidance may represent a behavioral adaptation in response to the normal rapid collection and burial of seeds by heteromyids.

M'Closkey, R. T. 1978. Niche separation and assembly in four species of Sonoran Desert rodents. Amer. Nat. 112:683-694.

Abstract: Current ecological theory predicts limits to the closeness of species packing. Increased competition from more competitors should result in greater average niche separation. This idea was tested for locally sympatric heteromyid rodents in part of the Sonoran Desert of Arizona, and the predictions were verified. As a consequence of diffuse competition, niche separation increases with species diversity, and rodent species show separation on both niche dimensions quantified in this study (seed-size collection and habitat utilization). However, when local diversity is low (Dipodomys merriami-Perognathus penicillatus), rodents are very similar in their overall

utilization of both dimensions. As diversity increases, first seed-size differences then subsequently both seed-size and habitat differences are apparent. Therefore, the pattern of niche separation and diversity demonstrates niche dimensionality in this fauna.

The pattern of niche separation and diversity also accounts for the occurrence of specific combinations of species (local assemblies). Of all possible pairs and triplets of species that can be constructed by computing niche separation, the observed assemblies are those showing minimum separation and hence maximum utilization of resource space. Imaginary assemblies are undersaturated. Compatibility of species does not appear to be important in determining the species composition of these heteromyid rodent assemblies.

M'Closkey, R. T. 1981. The principle of equal opportunity: a test with desert rodents. Can. J. Zool. 60:1968-1972.

Abstract: A basic assumption of the theory of niche overlap and limiting similarity is that the use of limited resources by coexisting species is proportional to resource availability. I provide a test of this assumption with desert rodents using microhabitat structure as a resource. Utilized and available microhabitat frequencies were compared in four desert rodent species. Some rodent species departed significantly in utilized microhabitats from that expected on the basis of availability. However, cumulative utilization frequencies for all other rodent species corresponded closely to the frequency of available microhabitats. Therefore, the assumption of constant ratios of utilization/availability of resources (microhabitats) was not falsified for the entire guild, although

individual rodent species used some microhabitats disproportionately.

Mellink, E. 1985. Agricultural disturbance and rodents: three farming systems in the Sonoran Desert. J. Arid Environ. 1985:207-222.

Abstract: Rodent data were obtained from three agroecosystems and their 'natural' equivalents in the Sonoran Desert. These data were treated by use of Brillion's diversity index, and the Shannon-Weaver index was computed using biomass. The values obtained were analyzed using three habitat diversity indexes, Sorensen's similarity coefficient, and by mapping the trapping stations on vegetation maps. The key factor in high abundance and diversity of rodents in two of the agroecosystems, was the presence of colonizing plant species in disturbed areas.

Moorhead, D. L., F. M. Fisher, and W. G. Whitford. 1988. Cover of spring annuals on nitrogen-rich kangaroo rat mounds in a Chihuahuan Desert grassland. Am. Midland Nat. 120:443-447.

Abstract: Species composition and cover of spring annual plant communities on banner-tailed kangaroo rat (Dipodomys spectabilis) mounds in a northern Chihuahuan Desert grassland differed from those on intermound areas. After seasons of adequate precipitation, cover of annual plants was greater on mounds than on adjacent areas; dominant species on mounds were those known to

increase with nitrogen fertilization. Soil nitrogen content was consistently higher in mound soils than in intermound soils; however, plant cover on mounds was not different from intermound areas following periods of limited precipitation despite differences in nitrogen levels. Patterns of species composition and cover of annual plants on kangaroo rat mounds are attributed to differential species responses to water and nutrient availabilities.

Moroka, N., R. F. Beck, and R. D. Pieper. 1982. Impact of burrowing activity of the bannertail kangaroo rat on southern New Mexico desert rangelands. J. Range Manage. 35:707-710.

Abstract: The impact of burrowing activity of the bannertail kangaroo rat (Dipodomys spectabilis) on southern New Mexico desert rangelands was investigated. The study was conducted on black grama (Bouteloua eriopoda), dropseed (Sporobolus spp.), and mesquite (Prosopis glandulosa) grassland vegetation types. Mound density was highest in the black grama type, somewhat intermediate in the dropseed type, and lowest in the mesquite-grassland type. The surface area occupied by mounds averaged 2% over all vegetation types in the study area. Plant cover was generally greater off mounds than on mounds. Annual plant cover was greater on mounds than off mounds, suggesting that activities of bannertail kangaroo rats promote the presence of annuals.

Ortega, J. C. 1987. Den site selection by the rock squirrel (Spermophilus variegatus) in southeastern Arizona. J. Mammal. 68:792-798.

Abstract: Physical and vegetational characteristics of rock squirrel (Spermophilus variegatus) den sites were investigated during 1983, 1984, and 1985 at the National Audubon Society's Appleton-Whittell Biological Research Sanctuary in southeastern Arizona. Relative to habitat availability, rock squirrel den sites occurred in greater than expected frequencies in oak savanna and riparian habitats. A comparison between 56 den sites and 40 control locations in rock squirrel-occupied habitat revealed significant differences ($P < 0.002$) for 12 (52.2%) of 23 physical and vegetational variables. Compared to control locations, dens were located 1) on steeper slopes, 2) in shadier sites, 3) closer to oaks, Quercus spp., 4) closer to washes, 5) associated with prominent potential lookout points, 6) in areas with less ground cover, and 7) associated to a lesser degree with more northerly facing slopes. Discriminant function analysis correctly classified 81.3% of den locations and control sites using only two variables, percent shade and angle of slope.

Ortega, J. C. 1990. Home-range size of adult rock squirrels (Spermophilus variegatus) in southeastern Arizona. J. Mammal. 71:171-176.

Abstract: Home-range sizes of adult rock squirrels (Spermophilus variegatus) were studied in southeastern Arizona. Twenty-eight adult rock squirrels were radiocollared for various periods from 28 May 1986 to 7 November 1986 and from 15 May 1987 to 19 June 1987. Home-range size was determined by the 95% minimum-convex-polygon method. Data were analyzed monthly and according to reproductive condition. Ranges of adult males were largest during the breeding season (May and June) and generally decreased in size during the remainder of the year. Home-range size

of adult females did not vary significantly according to month when all individuals were considered. Also, there was considerable intra- and intersexual overlap of home ranges.

Ortega, J. C. 1990. Reproductive biology of the rock squirrel (Spermophilus variegatus) in southeastern Arizona. J. Mammal. 71:448-457.

Abstract: Rock squirrels (Spermophilus variegatus) were studied from July 1983 to June 1987 in an oak (Quercus sp.) savanna in southeastern Arizona. Adult males had testes in scrotal position from late March until at least early July. Estrous females were observed from 15 May (the earliest that summer research began in any year) to 16 June. Lactating adult females were observed from early June to early October, and, depending upon the year, the percentage of lactating adult females peaked from early July to late August. The percentage of adult females not lactating during the peak lactation period (16 June - 15 September) ranged from 20 to 33% during a particular year. Yearling males had scrotal testes, and some (56%) yearling females lactated. Mating occurred from mid-April to early July. The mating period lasted approximately 9 weeks, and the timing of the mating period was associated closely with heavy summer rains, as juveniles first emerged shortly after the beginning of the rains and the concomitant increase in production of vegetation. Compared to many other ground-dwelling squirrels, rock squirrels in southeastern Arizona had a long breeding season that seemed to be associated with the extent of the summer rainy season and to the absence of a relatively early, cold winter that limits aboveground activity of many North American ground squirrels during autumn and winter.

Parmenter, R. R., J. A. MacMahon, and S. B. VanderWall. 1984. The measurement of granivory by desert rodents, birds and ants: a comparison of an energetics approach and a seed-dish technique. J. Arid Environ. 1984:75-92.

Abstract: The relative importance of granivorous rodents, birds and ants in four North American ecosystems was examined using two methods: an energetics approach (Population Daily Energy Budgets, or PDEBs); and an experimental seed-dish technique. Rodent, bird and ant population densities, combined with species-specific Daily Energy Budgets (DEBs), were used to compute the seed consumption 'pressure' from each taxocene on the seed pool. Seed consumption at sites in the Chihuahuan Desert/Grassland transition zone, the Sonoran and Mojave Deserts, and the Intermountain Basin Shrub-steppe, was estimated by offering each granivore taxocene exclusive access to seed-dishes containing either a native-seed mix or commercial millet. The ratios of rodent, bird and ant PDEBs were compared with the amounts of seeds actually taken by each taxocene from the seed-dishes. The following conclusions were made.

(1) Rodents were more 'important' (energetically) than birds on the Sonoran, Mojave and Intermountain Basin study sites, but birds were of equal or greater importance as rodents on the Chihuahuan study sites.

(2) Birds removed far fewer seeds from seed-dishes than predicted from their PDEBs.

(3) Rodents, birds and ants removed more millet and used more seed-dishes containing millet than those containing the native-seed mix.

(4) Seed-dish data should be interpreted with caution, due to differential responses by rodents, birds and ants.

(5) An energetics approach to desert granivory can provide reliable information about granivore impacts on seed reserves, but requires large data sets and biologically realistic estimators to produce accurate, high-precision results.

Price, M. V., and N. M. Waser. 1985. Microhabitat use by heteromyid rodents: effects of artificial seed patches. Ecology 66:211-219.

Abstract: Coexisting heteromyid rodent species differ in their affinities for foraging microhabitats. Bipedal forms (Dipodomys, Microdipodops) use open spaces preferentially, while quadrupedal forms (Perognathus) use spaces under or near vegetation. Despite consistent reports that these preferences occur in heteromyid assemblages throughout North American deserts, and despite frequent speculation about the importance of foraging economics and predation risk in producing them, few experimental analyses of microhabitat use exist. Here we describe studies showing that (1) microhabitat distinguished by heteromyids in nature differ in seed abundance, soil particle size, and soil density, all of which are features that have been shown to influence heteromyid foraging efficiency; (2) four coexisting species differ in their preferences for artificial seed patches in a large laboratory foraging arena, and differences in the properties of preferred and nonpreferred patches correspond qualitatively to differences in the attributes of preferred and nonpreferred microhabitats in nature; and (3) microhabitat use in nature, as measured by livetrapping, can undergo rapid shifts that track the location of preferred artificial seed patches placed either in open spaces or under vegetation. These results suggest that divergent microhabitat specializations of coexisting

heteromyids are in part functions of divergent preferences for the particular combinations of seeds and soils found in various microhabitats. Further experimental studies are needed, however, to determine whether these preferences can be predicted accurately from knowledge of the economics of foraging, and to what extent other factors may also influence microhabitat choice.

Reichman, O. J., and K. M. Van De Graaff. 1973. Seasonal activity and reproduction patterns of five species of Sonoran Desert rodents. Am. Midland Nat. 90:118-126.

Abstract: Activity patterns of five species of Sonoran Desert rodents (Dipodomys merriami, Perognathus amplus, P. intermedius, P. baileyi and Peromyscus eremicus) were closely related to temperature fluctuations, the heaviest species being most affected by high temperatures. There was a direct correlation between low ambient temperature, body weight and inactivity, with the lightest rodent, P. amplus, being the least active in the winter. D. merriami had two reproductive peaks (June and October) during the year. The three species of Perognathus reproduced only in the early summer. Young Peromyscus eremicus were consistently trapped through the summer and autumn.

Thompson, D. B., J. H. Brown, and W. D. Spencer. 1991. Indirect facilitation of granivorous birds by desert rodents: experimental evidence from foraging patterns. Ecology 72:852-863.

Abstract: In order to quantify the response of birds to experimental manipulations of seed

availability and densities of granivorous rodents and ants, we counted granivorous birds and measured diurnal and nocturnal seed removal on 24 plots during winter months in the Chihuahuan Desert. Removal of single, widely spaced millet seeds provided a reliable measure of bird and rodent foraging activity. Avian foraging activity increased in response to supplemental seeds, but decreased in response to long-term removal of all rodents and all ants. Although birds potentially compete for seeds with rodents and ants, these results suggest that, in the long term, indirect facilitation dominates the interactions among all three taxa. The positive effect of the other granivores on birds may be mediated through changes in habitat structure (e.g., reduction in the density of annual plants). The increase of avian foraging in response to seed addition and the high spatial and temporal variance in the patterns of seed removal by birds indicate that in desert habitats granivorous birds use their mobility to find and exploit high concentrations of seeds. Thus, birds may reduce the spatial variation in seed abundance and reduce the densities of seeds available to other granivores. The foraging behavior of birds and rodents revealed by these experiments clarifies the response of granivores to experimental manipulations reported earlier, such as the lack of biomass compensation by rodents in response to seed addition.

Valone, T. J., J. H. Brown, and E. J. Heske. 1994. Interactions between rodents and ants in the Chihuahuan Desert: an update. Ecology 75:252-255.

Valone, T. J., and J. S. Brown. 1989. Measuring patch assessment abilities of desert granivores. Ecology 70:1800-1810.

Abstract: We develop two criteria for measuring patch assessment ability. First, we examine the ability of foragers to equalize benefits and costs at manipulated resource patches. Second, we compare patch utilization patterns of four possible foraging strategies (prescient, fixed time, Bayesian, and rate assessor) with actual foraging patterns. Experiments with several desert rodent and avian species suggest that Merriam's kangaroo rat may obtain the best estimate of patch quality, followed by the round-tail ground squirrel and Arizona pocket mouse. Kangaroo rats exhibited both a prescient and Bayesian strategy. Pocket mice and ground squirrels exhibited both a fixed-time and Bayesian strategy. Gambel's Quail appeared to be the least sophisticated forager and exhibited only a fixed-time strategy.

The fixed-time strategy was observed most frequently in the low variance environment where patch differences were relatively minor. In general, increased patch variation led to poor patch estimates but allowed employment of sophisticated foraging strategies. Avian group foragers did not obtain better estimates of patch quality than solitary foragers.

Zeng, Z., and J. H. Brown. 1987. Population ecology of a desert rodent: Dipodomys merriami in the Chihuahuan Desert. Ecology 68:1328-1340.

Abstract: We show that the extremely flexible life history and other facultative behaviors of

the kangaroo rat, Dipodomys merriami, facilitate adult survival and enable this small mammal to maintain remarkably stable populations despite wide, unpredictable fluctuations in its desert environment. Mark-recapture methods provided data on population density, growth, reproduction, dispersal, and survival for a population of D. merriami in the Chihuahuan Desert of southeastern Arizona from 1978 to 1984. Population density showed both annual and interannual fluctuations, but varied only from about 3 to 15 individuals/ha.

The life history is characterized by long survival (up to at least 3.5 yr), modest and variable reproductive effort (zero to at least two litters per year, and an average of two young per litter), slow growth and maturation of young (at least 3 mo from birth to reproductive maturity), and frequent, facultative dispersal of adults as well as juveniles (75% of the males and 59% of the females that lived >4 mo dispersed). This combination of life history traits enabled D. merriami to confine reproduction to favorable periods, with the result that although adults of both sexes showed a loss of body mass associated with reproduction, there was no evidence that they experienced increased risk of mortality. Frequent and male-biased dispersal of adults is probably not unique to this species. Most standard methods of analyzing mark-recapture data probably underestimate the frequency of dispersal and its effects on sex ratio and genetic structure.

Bock, C. E., and J. H. Bock. 1994. Effects of predator exclusion on rodent abundance in an Arizona semidesert grassland. Southwestern Nat. 39:208-210.

Drewek, J. Jr., T. H. Noon, R. J. Trautman, and E. J. Bicknell. 1981. Serologic evidence of leptospirosis in a southern Arizona coyote population. J. Wildl. Dis. 17:33-37.

Abstract: Histologic examination of kidney tissue from a morbid coyote (Canis latrans) suggested a leptospiral infection. Sera from nine wild coyotes captured subsequently in the same general area were tested by therapid plate agglutination method. Four of nine sera contained antibodies to Leptospira canicola, while one serum also contained antibodies for L. icterohaemorrhagiae. Epidemiology and morbidity are discussed.

Ortega, J. C. 1987. Coyote food habits in southeastern Arizona. Southwestern Nat. 32:152-155.

Ortega, J. C. 1988. Activity patterns of different-aged coyote (Canis latrans) pups in southeastern Arizona. J. Mammal. 69:831-835.

Stolzenburg, H. W., and V. W. Howard, Jr. 1989. Activation of liquid bait devices by coyotes in southern New Mexico. Wildl. Soc. Bull. 17:306-312.

Allen, R. W. 1955. Parasites of mountain sheep in New Mexico, with new host records. J. Parasitol. 41:583-587.

Abstract: Historical accounts of parasites in bighorn sheep are discussed. A post-mortem study of 9 bighorn sheep found 9 different species of parasites, with pinworms being most prevalent. Each animal harbored 1 or more species of parasites.

Allen, R. W., and C. B. Kennedy. 1952. Parasites in a bighorn sheep in New Mexico. Proc. Helminthol. Soc. Wash. 19:39.

Abstract: An adult male bighorn sheep was examined 1 h after death for internal and external parasites. The ram was heavily infested with the winter tick (Dermacentor albipictus). Other parasites found included the spinose ear tick (Otobius megnini), Cystericercus tenuicollis, and the nematodes Nematodirus spathiger, Trichuris spp., and Skrjabinema spp.

Bavin, B. 1980. Post-release study of desert bighorn sheep in the Big Hatchet Mountains, New Mexico. Desert Bighorn Counc. Trans. 24:12-14.

Abstract: The post-release movements of 14 bighorn sheep held for 4 months in a 44-acre

enclosure were documented. Soon after the release, the herd was joined by 4 rams from the indigenous population. Ewes returned to the area of the release for lambing. Introducing sheep in an uninhabited portion of the range caused an expansion in home range of some indigenous rams.

Bock, C. E., and J. H. Bock. 1979. Relationship of the collared peccary to Sacaton grassland. J. Wildl. Manage. 43:813-816.

Brown, D. E. 1972. The status of desert bighorn sheep on the Papago Indian Reservation. Desert Bighorn Counc. Trans. 16:30-35.

Abstract: There are less than 50 bighorn sheep on the Papago Indian Reservation. Bighorn sheep habitat is available but the lack of water because of depletion by man has led to the concentration and reduction of sheep, which may lead to their extermination.

Brown, D. E., and R. S. Henry. 1981. On relict occurrences of white-tailed deer within the Sonoran Desert in Arizona. Southwestern Nat. 26:147-152.

Abstract: Extirpations of local populations of white-tailed deer (Odocoileus virginianus couesi) within the Sonoran Desert in Arizona are discussed. Seasonal drought is thought to exclude

this animal from western Arizona. The recent elimination of isolated populations at the western periphery of the species range is thought to be due to an increase in the incidence and variability of spring drought since 1950. Observed survival rates of white-tailed deer fawns correlated significantly with spring (June) and autumn (November) drought indices.

Elenowitz, A. S. 1982. Preliminary results of a desert bighorn transplant in the Peloncillo Mountains, New Mexico. Desert Bighorn Counc. Trans. 26:8-11.

Abstract: Twelve ewes from Arizona and 10 rams from a captive population at the Red Rock Wildlife Experimental Area, New Mexico were captured and released into a 40-acre holding paddock in the Peloncillo Mountains. The ewes were held for 7 months and the rams for 2 prior to their release. An additional 6 rams were free-released following the paddock release. Post-release mortality, behavior, and movements of the bighorn sheep are detailed.

Gordon, S. P. 1953. Age classification, sex ratio and reproduction of bighorn sheep. New Mexico Dep. Game and Fish, Fed. Aid Proj. W-68-R-1.

Abstract: In the Big Hatchet Mountains, New Mexico, lambing season ran from late October to May.

Gross, J. E. 1960. Investigation of seasonal sheep and deer habitat factors. New Mexico Dep. Game and Fish, Fed. Aid Proj. W-100-R-1.

Abstract: The Big Hatchet Mountains big game range may be classified as a multiple use habitat. The area is used by wild populations of mule deer, bighorn sheep, and javelina, and by domestic populations of cattle, horses, and pigs. Interspecific relationships occur primarily between mule deer, bighorn sheep, and cattle. Sheep use during most of the year is confined to the desert-shrub vegetation type between the elevations of 4,500 ft and 6,500 ft. The distribution of sheep through this range is not constant.

Serious competition for food plants undoubtedly occurred during the years from 1950 to 1956, but present browse conditions in the form of annual reproduction seem to be satisfactory. Thus, except for periods when excess deer numbers create congestion and undue stress on the browse supply, competition for food plants between sheep, deer, and cattle does not reach a critical state.

During the drought period habitat conditions deteriorated seriously and the ungulate populations suffered severe losses. Sheep used water at least during the months of June, August, September, December, February, and March, and all sheep observed on the mountain were within 1.25 mi of water.

The lamb crop may be dependent on free water being available during relatively short but key periods in breeding, gestation, or lactation.

The relationship that occurs between sheep, vegetative succulence, and moisture conditions during various seasons of the year furnished important data concerning water development. The

satisfying of water requirements through metabolism or vegetative succulence depends directly upon forb and browse growth. During periods when summer and winter rains are inadequate or do not occur, such as in 1954 and 1956, moisture storage in the soil is low and forb growth is retarded. Succulence and metabolized water may then be inadequate, and if sufficient free water is not available, a physiological water shortage occurs. The first factor to be compromised is reproduction. This shortage of early spring moisture occurred in 1954 and 1956 when the apparent lamb crop failures were noted. When summer rains failed as they did in 1956, the breeding activities may also be affected.

Considering various references, it is apparent that sheep at certain times of the year require water above that furnished by metabolism or vegetative succulence.

Jacobsen, R. D., and L. O. Wilson. 1972. Habitat of the Mexican bighorn sheep in the Big Hatchet Mountains of New Mexico. Desert Bighorn Counc. Trans. 16:36-46.

Abstract: Three vegetative types occur in the Big Hatchet Mountains: creosote-mesquite, desert shrub, and pinyon-juniper. The major plant species in each vegetative type are listed. The availability of water, cover, and living space for bighorn sheep are discussed. Potential limiting factors include competition for forage by livestock and deer, drought, lack of cover, disease, parasites, insects, and predation.

Krausman, P. R., W. W. Shaw, and J. L. Stair. 1979. Bighorn sheep in the Pusch Ridge Wilderness Area, Arizona. Desert Bighorn Counc. Trans. 23:40-46.

Abstract: Bighorn sheep distribution in the Santa Catalina Mountains has declined since 1936 due to roads, trails, and human activity. The population is now restricted to the northwest and southwest portions of the range. From annual aerial surveys and ground counts, the population is estimated at 70 to 100 individuals and apparently is stable and healthy. Between 1962 and 1978, 72 permits were issued for hunting bighorn sheep in the Santa Catalina Mountains and 22 mature rams were shot. Body measurements and examinations of 12 harvested rams indicate that these sheep are heavier than other rams in Arizona. The mean field-dressed weight is 68 kg. Long-term effects of man on this sheep population are unclear. Tucson lies at the base of the Santa Catalina Mountains and photographers, hikers, birdwatchers, hunters, and other recreationists frequently use the Pusch Ridge Wilderness Area.

Larsen, P. A. 1971. Bighorn sheep management in New Mexico. Trans. North Am. Wild Sheep Conf. 1:16-21.

Abstract: The 2 populations of bighorn sheep in New Mexico total 200-275 animals. The history and status of herds in the San Andres and Big Hatchet Mountains are discussed. The New Mexico Game and Fish Department's bighorn sheep management program is summarized. This includes plans for the development of a sheep rearing facility and future reintroductions into the

Guadalupe Mountains. Early sightings (1540-1946) of bighorn sheep in the state are referenced.

Lee, L. 1960. The possible impact of Barbary sheep in New Mexico. Desert Bighorn Counc. Trans. 4:15-16.

Abstract: A warning is raised about possible diseases and parasites which may be transmitted by Barbary sheep to native ungulates.

Lenarz, M. S. 1978. Intra-specific variation in the social structure of Ovis canadensis. M.S. Thesis, New Mexico State Univ., Las Cruces. 34pp.

Abstract: Two hypotheses were tested with respect to the influence of forage availability on the social structure and reproductive strategy of bighorn sheep in the Big Hatchet Mountains. The hypotheses are: 1) the periodicity and predictability of forage production is related to the reproductive strategy, and 2) temporal variation in forage availability is related to social structure. Breeding in the population was nonseasonal, differing from the hypothesis prediction. The social structure in the Big Hatchet Mountains also differed from that of bighorn sheep populations in temperate-alpine areas. These differences reflect the reproductive strategy and not the temporal variation in forage availability. The populations' reproductive strategy may be a response to a low population density and relatively abundant high-quality forage. Differences in the social structure

may be the result of ecological variables, with the ecological strategies being the proximate selective force.

Lenarz, M. S. 1979. Social structure and reproductive strategy in desert bighorn sheep (Ovis canadensis mexicana). J. Mammal. 60:671-678.

Abstract: Hypotheses have been made that predictable, periodic plant productivity set birth seasons for bighorn sheep and shortened birth and rutting seasons. Because forage production in the Chihuahuan Desert is most predictable in July, August, and September, specific differences in the breeding behavior of bighorn sheep in the Big Hatchet Mountains are predicted: 1) the peak in lambing occurs in mid-July, 2) the peak in rutting activity is in mid-January, and 3) the duration of lambing and rutting seasons is longer than in more northern populations to allow for a delay in the onset of summer productivity. Geist proposes that temporal variation in the availability of forage may result in different social organizations. On the basis of differences in seasonality and duration of forage availability between alpine climates and that of the Chihuahuan Desert , specific differences are predicted: 1) sexually mature rams are present on ewe ranges only during mid-winter rut, and 2) ewe and ram groups are segregated into different areas outside the rutting period to minimize the potential for intraspecific competition in drought years. The hypothesis relating timing and duration of breeding seasons to periodicity and predictability of forage production is not supported. Eighty percent of the lambs were born outside the predicted lambing season during periods when precipitation was low and forage production was unpredictable. The absence of

seasonal breeding may imply a "gambling" strategy where young are produced throughout the year and only those born during periods of forage production survive. In the Big Hatchet Mountains, the association of rams with ewe groups is not limited to predicted mid-winter rut. Because of the low density of this population and the nonseasonal breeding behavior of some ewes, rams would increase their fitness by accompanying ewe groups for longer periods. Segregation of ewe and ram groups from January to June coincided with a period when most births occurred, which maximized individual fitness by reducing energetic requirements of ewes and minimizing the potential of intraspecific competition.

Lenarz, M. S., and W. Conley. 1982. Reproductive gambling in bighorn sheep (Ovis): a simulation. J. Theor. Biol. 98:1-7.

Abstract: Bighorn sheep in deserts, which live in an unpredictable environment, have been hypothesized to use reproductive gambling, by which they increase fertility by continuous breeding. Seasonal and gambling strategies were simulated with survival schedules generated as a function of precipitation. The seasonal strategy had a higher finite rate of increase even though annual per capita fertility was increased under the gambling strategy. Unless the survival of lambs born outside the optimum period is substantially increased, reproductive gambling is not an ecologically stable strategy.

Levy, S. H. 1963. Bighorns and Papagos. Desert Bighorn Counc. Trans. 7:114-119.

Abstract: The Papago Indian Reservation occupies 3 million acres in southcentral Arizona and is the second largest Indian reservation in the United States. Bighorn sheep occur in most of the major mountain ranges but are not managed and face an uncertain future unless a management program is established.

Mearns, E. A. 1907. Mammals of the Mexican boundary of the United States, Part I. U.S. National Museum Bull. 56:1-530.

Abstract: Distributions and descriptions are provided for bighorn sheep (O. c. mexicanus). A new species is suggested: the Gaillard bighorn (O. c. gaillardi). A description of the type and comparisons are made with O. C. mexicanus.

Monson, G. 1966. The place of refuges in desert bighorn management. Desert Bighorn Counc. Trans. 10:21-23.

Abstract: Refuges are important for preserving bighorn sheep habitat. Competing uses can be strictly controlled and special efforts made for increasing the carrying capacity of bighorn sheep habitat. Research is encouraged on refuges. Refuges are also a reservoir for restocking depleted

ranges. Other benefits include many recreational activities.

Neal, K. S. 1974. Desert bighorn sheep in Arizona--in the year 2050. Desert Bighorn Counc. Trans. 18:28.

Abstract: Problems confronting bighorn sheep in Arizona are discussed; problems include politics, technology, and population growth.

Powell, L. E. 1967. Public domain and Arizona bighorn sheep. Desert Bighorn Counc. Trans. 11:13-15.

Abstract: The 1964 Classification and Multiple Use Act changed the direction of the Bureau of Land Management from that of disposal of the public domain to retention and management. The Bureau has recommended retention of mountainous regions of western Arizona known to contain bighorn sheep. Increased management of those mountain ranges and of sheep in general is contemplated. The paper is a general discussion of the Bureau's objectives as they related to sheep management in Arizona.

Purdy, K. G. 1981. Recreational use of desert bighorn sheep habitat in Pusch Ridge Wilderness. M.S. Thesis, Univ. Arizona, Tucson. xxpp.

Abstract: This study examines the recreational uses and users of natural bighorn sheep habitat in Pusch Ridge Wilderness. The majority of visitors, using lower canyon sites, present little threat to the bighorn sheep. Back country visitors, their activities, and lengths of stay pose a greater threat to bighorn sheep. The presence of dogs with back country visitors are an additional threat. A list of recommendations are made for the management of Pusch Ridge with regard to recreational use.

Purdy, K. G., and W. W. Shaw. 1981. An analysis of recreational use patterns in desert bighorn habitat: the Pusch Ridge Wilderness case. Desert Bighorn Counc. Trans. 25:1-5.

Abstract: The article reports on the results of a study designed to examine recreational uses of bighorn sheep habitat in a wilderness area. Objectives of the study were to determine numbers and activities of recreators in the wilderness area, preferences and perceptions of the wilderness areas by users, degree of interaction between recreators and bighorn sheep, and to evaluate recreational impacts on sheep. Data were collected using trail counters, unmanned survey stations, questionnaires, telephone surveys, and direct observation. Back country users appear to pose the greatest threats to sheep. A number of recommendations are made to help mitigate the impacts of human-sheep conflicts.

Watts, T. J. 1979. Detrimental movement patterns in a remnant population of bighorn sheep (Ovis canadensis mexicana). M.S. Thesis, New Mexico State Univ., Las Cruces. 185pp.

Abstract: High lamb mortality was attributed to bighorn sheep movements 4 km south of the Big Hatchet Mountains to Cairn Hills. Movements occurred due to mineral craving, especially for sodium. A model that related increased forage potassium levels in emergent vegetation to increased loss of fecal sodium, and thus a sodium craving, was used to explain the temporal periodicity of bighorn sheep movements to Cairn Hills and mineral lick use. The majority of the movements occurred during the primary growing season, July through October. Sheep at the Big Hatchet Mountains were independent of free water sources year-round. An adaptation to surviving in a historically waterless habitat may be increased seasonal use of cactus. There was an approximate 50% decline in the population during the project, to 10 adults and 3 lambs by June 1978.

Watts, T. J. 1979. Status of the Big Hatchet desert sheep population, New Mexico. Desert Bighorn Counc. Trans. 23:92-94.

Abstract: This study was conducted to determine the status of the population. In the late 1950's the population declined from 125 - 150 to 20-25 animals and has since fluctuated around this low number. Herd distribution was reduced form its former range. During the decline, population size was reduced 40% and adult mortality nearly reached 50%. Excessive lamb mortality was directly related to abnormal movement patterns across creosote-bush flats. This was probably in

response to a craving for supplemental sodium. This remnant population is describe by aperiodic estrous, an extended breeding period, regular movement across flat country, and an apparent independence from free-standing water. Prickly pear, a possible alternate water source, comprised 53% of the June diet.

Watts, T. J., and W. Conley. 1981. Extinction probabilities in a remnant population of Ovis canadensis mexicana. Acta Theriol. 26:393-405.

Abstract: The population of bighorn sheep in the Big Hatchet Mountains had a 50% decline in its adult component between 1976 and 1978 (from 22 to 13). Computer simulations were conducted and determined the probability of extinction of the 1978 population to be 12%. The observed decline increased the extinction rate from 0% to 12% and decreased the potential population size after 18 years by 42%. Using computer simulations, hypothetical reductions in the population and hypothetical supplemental introductions to the population were tested to determine their effects on the probabilities for survival or extinction of the population.

Wilbanks, J. M. 1959. Patrol and protection problems. Desert Bighorn Counc. Trans. 3:34-36.

Abstract: Violations involved with bighorn sheep management are discussed; they are poaching, shooting illegal rams, and smuggling shot sheep into the United States from Mexico.

Allen, R. W. 1960. Diseases and parasites of Barbary and bighorn sheep in the southwest. Desert Bighorn Counc. Trans. 4:17-22.

Abstract: Barbary sheep were collected along the Canadian River, New Mexico in 1955, and bighorn sheep were collected in the Big Hatchet Mountains, on the San Andres Refuge, and in the Sandia Mountains, New Mexico in 1954, 1951, and 1959, respectively. Bighorn sheep were collected on the Kofa Game Range, Arizona in 1953 and 1954. Animals were studied to obtain information concerning tick infestation, blood parasites, worm parasites, and gross pathology. Bighorn sheep from the Kofa Game Range showed the only evidence of gross pathology: 1 ram had horny dermatitis, and infections with Corynebacterium were common. Winter ticks occurred in all localities with the highest incidence in sheep from the Big Hatchet Mountains. Ear ticks were found only on sheep from the San Andres Refuge and the Big Hatchet Mountains. Blood parasites were not found. All sheep, with the exception of 1 ram from the Kofa Game Range, had worm parasites. The most harmful parasite found was the large stomach worm in Barbary sheep and bighorn sheep from the Big Hatchet Mountains. Pinworms were the most prevalent parasites. Lungworms were only found in bighorn sheep from the Sandia Mountains. Sheep from the Big Hatchet Mountains were parasitized primarily be nematodes. Sheep from the Kofa Game Range were infected with tapeworms but no nematodes except pinworms.

Hansen, R. M. 1976. Foods of free-roaming horses in southern New Mexico. J. Range Manage. 29:347.

Abstract: Seasonal foods of free-roaming wild horses were determined in southern New Mexico by microhistological analyses of fecal samples. The most important forages consumed annually by wild horses were Russianthistle (29%), dropseed (21%), mesquite (16%), and Junegrass (12%). Seasonal differences in the percentages of the diets were found for mesquite, Junegrass, and saltbush.

Bowker, R. W. and B. K. Sullivan. 1991. Bufo punctatus and Bufo retiformis (red-spotted toad, Sonoran green toad), natural hybridization. Herp. Rev. 22:54.

Case, T. J. 1990. Patterns of coexistence in sexual and asexual species of Cnemidophorus lizards. Oecologia 83:220-227.

Abstract: The lizard genus Cnemidophorus (family Teiidae) contains sexual as well as parthenogenetic species. The theoretical two-fold fitness advantage of asexuality does not translate into any obvious distributional or numerical superiority of the parthenogenic species in the southwestern U.S. and northern Mexico where their ranges overlap. I tested the prediction that the genetically diverse sexual species should have a higher between-individual niche width than a similar sympatric asexual species by studying the prey in stomach contents of sympatric and allopatric populations of C. tigris (sexual) and C. sonorae (asexual) in southern Arizona. The expectation proved true for niche breadths based on both prey length and prey taxa categories. The within-individual component of niche breadth was not different between species. Meaningful comparisons between species in sympatry and allopatry are confounded by the uncontrolled differences in the availability and diversity of food items between sites. Before the generality of these results can be assessed the study should be repeated in other areas where sexual and asexual species are syntopic and of similar body size.

Duncan, R. B. 1992. Lampropeltis pyromelana (Sonoran Mountain king-snake) predation. Herp. Rev. 23:81.

Germano, D. J. 1992. Longevity and age-size relationships of populations of desert tortoises. Copeia 1992(2):367-374.

Abstract: Based on minimum estimates of longevity of desert tortoises (Gopherus agassizii) that died in the field, few individuals live past 50 years. Approximately 29% of tortoises from the Sonoran Desert, 11% of tortoises from the eastern Mojave Desert, and approximately 5% of tortoises from the western Mojave Desert were estimated to be over 25 years. The greatest estimate of longevity for any individual was 48-53 years and came from the eastern Mojave Desert. The oldest individual from the western Mojave Desert was estimated to be 32 years, and the oldest individual from the Sonoran Desert was estimated to be 35 years. Comparisons of carapace length to age showed the highest rates of growth (0-25 years) for tortoises from the western Mojave Desert and Sinaloan habitats. Of the 4 major regions within the range of the desert tortoise, rates of growth were lowest in the eastern Mojave and Sonoran Deserts.

Germano, D. J. and C. R. Hungerford. 1981. Reptile population changes with manipulation of Sonoran Desert shrub. Great Basin Nat. 41:129-138.

Abstract: The diversity and abundance of reptiles were studied in 3 vegetation types on the

Santa Rita Experimental Range, Arizona. Total reptile sightings were greatest in undisturbed mesquite and mesquite with irregularly shaped clearings. No zebra-tailed lizards (Callisaurus draconoides) or desert spiny lizards (Sceloporus magister) were seen, and significantly fewer western whiptails (Cnemidophorus tigris) were in the mesquite-free area. Only the Sonora spotted whiptail (Cnemidophorus sonorae) was significantly more abundant in the mesquite-free area than in the undisturbed mesquite. In an effort to increase grass production for cattle in mesquite grasslands, it is preferable to clear irregularly shaped areas rather than to attempt total mesquite removal, if reptiles are to be considered.

Glenn, J. L. and R. C. Straight. 1990. Venom characteristics as an indicator of hybridization between Crotalus viridis viridis and Crotalus scutulatus scutulatus in New Mexico. Toxicon 28:857-862.

Abstract: One hundred and thirteen venoms from 46 populations of Crotalus viridis viridis were screened by immunodiffusion for protein toxins antigenically similar to the phospholipase A_2 (PLA) toxin 'Mojave toxin', using a polyclonal antibody to it's basic PLA subunit. Venom i.p. LD_{50} values in mice were recorded from 22 of the 46 populations. The venoms of 3 of 14 specimens from southwest (S.W.) New Mexico and 1 specimen from northern Arizona were immunologically positive by the immunodiffusion tests and produced low LD_{50} values (0.38-0.65 mg/kg) compared to all immunologically negative venoms (0.9-5.5 mg/kg). These 4 specimens were morphologically typical for C. v. viridis and their venoms were the only samples of 15

southern New Mexico specimens examined by reverse phase HPLC to exhibit peaks corresponding to the acidic and basic subunits of Mojave toxin. Alkaline polyacrylamide gel electrophoresis (PAGE) analysis of the recombined subunit peaks from the C. v. viridis venom from the S.W. New Mexico specimens showed more similarity to Mojave toxin from C. s. scutulatus venom than to similar toxins in C. v. concolor venom. The combined results of the immunodiffusion, lethal toxicity tests, HPLC profiles and PAGE analysis strongly suggest that the venoms of the 3 New Mexico specimens contain Mojave toxin(s), as a result of some previous hybridization with C. s. scutulatus. The northern Arizona specimen likely contains 'concolor toxin' through intergradation with C. v. concolor in its' genetic background.

Goldberg, S. R., C. R. Bursey, and N. Zucker. 1993. Gastrointestinal helminths of the tree lizard, Urosaurus ornatus (Phrynosomatidae).

Abstract: The gastrointestinal tracts of 205 Urosaurus ornatus were examined for helminths: 117 from Aguirre Spring, New Mexico; 73 from Doña Ana Mountains, New Mexico, and 15 from southern Arizona. Spauligodon giganticus was the most prevalent helminth (prevalence 24.8%, mean intensity 5.6) and occurred in all 3 samples. The Aguirre Spring sample had significantly higher prevalences of S. giganticus (38.5%) than the other 2 samples. In addition, third-stage larvae of Physaloptera sp. (prevalence 4.2%, mean intensity 3.5) and Oochoristica sp. (prevalence 4.2%, mean intensity 1.6) and tetrathyridia of Mesocestoides sp. (prevalence 3.2%, mean intensity 103.8) were recovered from the New Mexico samples. The finding of Mesocestoides sp. within skeletal

muscle in 1 specimen is noteworthy because it demonstrates that this parasite can migrate out of the body cavity. All findings represent new host records.

González-Romero, A., A. Ortega, and R. Barbault. 1989. Habitat partitioning and spatial organization in a lizard community of the Sonoran desert, Mexico. Amphibia-Reptilia 10:1-11.

Abstract: The spatial structure of a desert lizard community located in the state of Sonora, N.E. Mexico, was studied in October 1982 and June 1983. The community is composed of 17 species, and we analyzed the habitat partitioning and microhabitat utilization of 12 species recorded along 2 transects. We found that habitat and microhabitat selection plays a determining role in organizing this lizard community and its ecological meaning is discussed.

Iverson, J. B. 1989. The Arizona mud turtle, Kinosternon flavescens arizonense (Kinosternidae), in Arizona and Sonora. Southwestern Nat. 34:356-368.

Abstract: Fieldwork in Arizona and Sonora in 1981, 1982, and 1984 revealed 44 new localities for the Arizona mud turtle (Kinosternon flavescens arizonense), verified the presence of the turtle at or near 16 of the previously known 21 localities, demonstrated the microsympatry of this turtle with the Alamos mud turtle (Kinosternon alamosae), and provided the first information on

habitat, growth, and reproduction. Multivariate statistical analysis confirmed the distinctiveness of the taxon and revealed very little microgeographic variation among river basin populations. Despite its relatively small range in Arizona and Sonora the species is not considered threatened.

Iverson, J. B., E. L. Barthelmess, G. R. Smith, and C. E. deRivera. 1991. Growth and reproduction in the mud turtle Kinosternon hirtipes in Chihuahua, Mexico. J. Herp. 25:64-72.

Abstract: Growth and reproductive data from a single population of Kinosternon hirtipes in Chihuahua, Mexico are reported. Males grow faster and are larger than females by age 5 or younger. Females mature in 6 to 8 years at 95-100 mm carapace length. Ovulation occurs from at least early May to late September. Given the lengthy reproductive season, evidence from multiple sets of corpora lutea and enlarged ovarian follicles suggests an annual production of 4 clutches. Egg width and mass correlate positively with body length and mass, and negatively with clutch size when the effects of carapace length are removed. Clutch size based on corpora lutea averages 3 eggs (range 1-6). Clutch size correlates positively with body length and mass. Relative clutch mass (clutch mass/body mass minus clutch mass) averages 7.1% and is independent of body size. Comparisons are made with other kinosternine turtles.

Jennings, M. R. 1984. Predation on Sonoran spotted whiptails, Cnemidophorus sonorae (Teiidae), by the great-tailed grackle, Quiscalus mexicanus (Icteridae).. Southwestern Nat. 29:514.

Mahrt, J. L. 1987. Lizard malaria in Arizona: island biogeography of Plasmodium chiricahuae and Sceloporus jarrovi. Southwestern Nat. 32:347-350.

Abstract: Plasmodium chiricahuae gametocytes which infect the lizard Sceloporus jarrovi were compared from 5 montane islands in southern Arizona. The biogeography of S. jarrovi in its most northern distribution is clearly that of disjunct populations on montane islands. There were no significant differences in gametocyte size in lizards between the islands. Differences in lizards within areas were highly significant. The time (estimated at 8,000-12,000 years) since isolation of this host-parasite system may have been insufficient to demonstrate change in evolutionary patterns. Alternatively, differences in gametocyte size may not be a sensitive enough measure of coevolution.

MacKay, W. P., S. J. Loring, T. M. Frost, and W. G. Whitford. 1990. Population dynamics of a playa community in the Chihuahuan Desert. Southwestern Nat. 35:393-402.

Abstract: Population responses of desert playa organisms were examined following 2 separate rain storms (spring and late summer-fall) that flooded a playa and stock tank located in southern New Mexico. Invertebrate species that appeared following both floods included the crustaceans

Streptocephalus texanus, Thamnocephalus platyurus, Eulimnadia texana, Triops longicaudatus, Moina wierzejskii and the rotifers Brachionus sp., Polyarthra sp., and Pedalia sp. Moina wierzejskii produced 3 generations during the single spring flood while other species produced a single generation. Initial population levels for all species were very high. Fairy shrimp levels decreased quickly, and population levels of Moina wierzejskii were depressed until levels of all other species were low. Arthropod species did not produce large numbers of drought-resistant eggs in response to the lowering of the water level. Tadpoles of 2 species of anurans, the spadefoot toad (Scaphiopus multiplacatus) and the true toad (Bufo cognatus) occurred in the playa following spring flooding. Tadpoles of Bufo cognatus were not collected after the late summer rain. Tadpoles, particularly spadefoot toads, preyed on other tadpoles and fairy shrimp (Anostraca). Apparently, both biotic and abiotic factors were important in the population dynamics of playa organisms. Biotic interactions appeared more important during the second flood when the population densities of most species were higher.

McCloskey, R. T., R. J. Deslippe, and C. P. Szpak. 1990. Tree lizard distribution and mating system: the influence of habitat and food resources. Can. J. Zool. 68:2083-2089.

Abstract: We examined the distribution of an insectivorous iguanid lizard (Iguanidae: Urosaurus ornatus, tree lizard) in the Sonoran Desert of Arizona in 1984, 1986, and 1987. The purpose of the investigation was to examine the ecological correlates of lizard distribution and mating system. Data from 420 marked lizards which were captured 1552 times provided

information on habitat-level differences in lizard numbers and characteristics of home ranges in which oviposition occurred. In addition, we evaluated the role of arthropod food resources in the distribution of female home range and in the mating status of males. In dry washes, tree lizards occupied mesquite (Prosopis juliflora) trees, whereas in flatland habitat they lived in mesquite trees and other sites (dead mesquite and saguaro cactus, Carnegeia gigantea). Lizards were more abundant in dry washes than flatland habitat. The lizard mating system was variable and a greater proportion of males were polygynous in wash (33-67%) compared with flatland (7-33%) habitat. In the flatland, home ranges in which females oviposited could be distinguished from vacant sites by soil hardness, shrub cover, and the presence of wood rat (Neotoma albigula) nests. Arthropod abundance did not differ between female home ranges and nearest vacant site nor between habitats and among male territories. Therefore, food resource distribution does not appear to be a determinant of either female distribution or territory quality in male tree lizards.

M'Closkey, R. T., C. P. Szpak, and R. J. Deslippe. 1990. Experimental assessment of factors affecting the distribution of adult female tree lizards. Oikos 59:183-188.

Abstract: In the Sonoran Desert of southeastern Arizona, we conducted transplant experiments with adult female tree lizards (Urosaurus ornatus) to test the hypothesis that the presence of conspecific females plays a role in their settlement and home range use. We have observed aggregations of female tree lizards, most frequently in dry washes of mesquite (Prosopis juliflora) woodland, but also in flatland desert habitat where the experiments were conducted. We did 2 types

of transplants. In the first, we added a transplant female to the home range and territory of a resident pair (male-female), thereby creating a 2-female site. In the second, we removed a resident female and replaced her with a transplant female, thus producing a 1-female site. We conducted both pre-transplant and post-transplant censuses and the transplant experiments were conducted immediately after the pre-transplant censuses. Female lizards at both groups of transplant sites abandoned these sites compared with sham-transplanted controls. Therefore, the selection or use of home ranges by adult female tree lizards is not determined simply by the presence of other females. Cuing on conspecific females, even if present, is not sufficient for transplanted females to establish residence at unfamiliar sites.

Mendelson, J. R. III and W. B. Jennings. 1992. Shifts in the relative abundance of snakes in a desert grassland. J. Herpetol. 26:38-45.

Abstract: Distribution, diversity, and relative abundance of snake species on roads through desert grasslands in Arizona and New Mexico were compared to data in a previously published survey conducted about 30 years ago. We found a significant shift in the relative abundance of snake species: Thamnophis marcianus and Crotalus atrox have increased in relative abundance and C. scutulatus has decreased. These changes are correlated with succession of local Semidesert Grasslands to Chihuahuan Desertscrub. Analysis of distributions of Crotalus revealed that C. atrox was more common than C. scutulatus in scrub habitat while C. scutulatus was more common in the remaining grasslands.

Platz, J. E. and J. S. Frost. 1984. Rana yavapaiensis, a new species of leopard frog (Rana pipiens complex). Copeia 1984(4):940-948.

Abstract: Rana yavapaiensis, a distinctive new species of the R. pipiens complex, occupies lower elevation aquatic habitats
in the western third and southern half of Arizona and adjacent Sonora, Mexico. It is similar to but distinguishable from R. chiricahuensis and R. magnaocularis. The new species is sympatric over part of its range with R. chiricahuensis. Where they occur together the production of F_1 hybrids was low and presumed backcross individuals were not detected. Comparisons of preserved specimens of the new species with type specimens of both R. onca and R. fisheri indicate that R. yavapaiensis is distinct from each of these as well.

Sullivan, B. K. 1985. Sexual selection and mating system variation in anuran amphibians of the Arizona-Sonoran Desert. Great Basin Nat. 45:688-696.

Abstract: Mating system variation in anuran amphibians of the Arizona-Sonoran Desert was reviewed. Male density and breeding period duration were negatively correlated in seven bufonids and pelobatids. Variation in male mating behavior and ability of females to freely select their mates unhindered by active-searching males also was related directly to male density. These observations support hypotheses relating ecological factors to mating system organization. It is suggested that male calling behavior, and anuran lek mating systems in general, may be significantly influenced by predation on vocalizing males.

Tanner, W. W. 1987. Lizards and turtles of western Chihuahua. Great Basin Nat. 47:383-421.

_____. 1985. Snakes of western Chihuahua. Great Basin Nat. 45:615-676.

Woodward, B. D. 1987. Clutch parameters and pond use in some Chihuahuan Desert anurans. Southwestern Nat. 32:13-19.

Abstract: Clutch parameters of anurans breeding in temporary and permanent ponds in the Chihuahuan Desert differ and appear to reflect the selective regime within each pond type. Permanent ponds contain many predators and the tadpoles appear to be good at avoiding predators. Females using these ponds produce large clutches containing many small eggs. Temporary ponds appear to be areas of intense larval competition and females using these ponds produce small clutches composed of few relatively large eggs. Strong, divergent selection pressures in temporary and permanent ponds appear to be responsible for determining the breeding pond type each species uses in the Chihuahuan Desert.

Wygoda, M. L. and C. M. Chmura. 1990. Effects of shell closure on water loss in the Sonoran mud turtle, Kinosternon sonoriense. Southwestern Nat. 35:228-229.